SCIENCE

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CONTENTS:

Scientific Work of the Lick Observatory: PROFESSOR JAMES E. KEELER 665
The Early Presidents of the American Association, II. (with plate): DR. MARCUS BENJAMIN 670
The Best Movement for Handwriting: DR. R. S. WOODWORTH 679
A Census of the Fossil Vertebrata of North America: O. P. HAY 681
The International Association of Academies 684
Scientific Books:—
Burbury's Kinetic Theory of Gases: PROFESSOR EDWIN H. HALL. *Cesàro's elementi di calcolo infinitesimale:* PROFESSOR E. O. LOVETT. *Kirchhoff's Pflanzen- und Tierverbreitung:* PROFESSOR CONWAY MACMILLAN. *Wanklyn and Cooper on Sewage Analysis:* PROFESSOR W. P. MASON. *Hillyer's Laboratory Manual of Chemistry; Lengfeld's Inorganic Chemical Preparations:* PROFESSOR W. A. NOYES 685
Scientific Journals and Articles 692
Societies and Academies:—
American Mathematical Society: PROFESSOR F. N. COLE. *Torrey Botanical Club:* PROFESSOR E. S. BURGESS. *Science Club of the University of Wisconsin:* PROFESSOR WM. H. HOBBS .. 693
Discussion and Correspondence:—
Geological Time: DR. JOHN M CLARKE. *Newspaper Science:* PROFESSOR JAMES H. HYSLOP 695
Notes on Inorganic Chemistry: J. L. H 696
The November Meteors of 1899 697
Observations of the Total Solar Eclipse in 1900 698
The Imperial Department of Agriculture in the West Indies 699
The Proposed National University 700
Resolutions of the Seventh International Geographical Congress 700
Scientific Notes and News 701
University and Educational News 703

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*SCIENTIFIC WORK OF THE LICK OBSERVATORY.**

INSTRUMENTS AND SCIENTIFIC WORK OF THE OBSERVERS.

THE nature of the scientific work undertaken at the Lick Observatory is determined by such considerations as the unusually fine atmospheric conditions which prevail here, the nature of the instrumental equipment, and the number of observers on the staff. The general policy of the Observatory is to carry on investigations which cannot be pursued to so great advantage elsewhere. Thus, comets which are bright enough to be easily seen at the leading observatories receive only occasional attention, while comets which, by reason of their faintness or unfavorable position, are difficult of observation, are followed as closely as possible. Elaborate investigations dealing with large masses of data, and requiring a large force of computers, can only be undertaken by richly endowed observatories or by those which receive government assistance. The Lick Observatory makes the most of its natural advantages; and extended theoretical researches, which can be made as well in a city as at a fine observing station, do not form a part of our general plan.

As all the principal instruments of the

* Extract from the forthcoming report of the Director of the Lick Observatory to the President of the University of California, for the year ending Sept. 1, 1899.

Observatory are used on practically every clear night, the amount of work accomplished is very considerable, notwithstanding the smallness of the observing force, while the variety of instruments makes the field covered quite a wide one.

THE THIRTY-SIX-INCH REFRACTOR.

This splendid instrument is in perfect order. A small periodic error originally in the driving-gear has been almost wholly corrected by Professor Campbell (who has charge of the instrument), by introducing into the clock-train a periodic error of equal amount but opposite sign, so that the two errors neutralize each other.

About half the time of the 36-inch equatorial is devoted to spectroscopic determinations of the motions of stars in the line of sight, with the aid of the Mills Spectrograph. This department of the scientific work of the Observatory, which is probably as important as any work that can be done at the present time with a large telescope, has been admirably systematized by Professor Campbell, who is assisted in the observations and reductions by Mr. Wright. The probable error of a single determination is only about 0.25 kilometer for the best stars, a degree of accuracy which has never before been reached in such measurements. A correcting lens, which is placed in the cone of rays from the 36-inch objective, and which changes the chromatic aberration of the telescope so as to adapt it to photographic work, has added somewhat to the accuracy and very much to the convenience of the observations.

During the past year 522 spectrograms were obtained. Over 200 spectrograms were definitively, and about 500 approximately, measured and reduced.

In connection with this work, the following stars have been found to have variable velocities in the line of sight, and therefore to be revolving stellar systems: η Pegasi, χ Draconis, o Leonia, ξ Geminorum, ι Pegasi, θ Draconis, ε Libræ, β Capricorni, h Draconis, λ Andromedæ, ε Ursæ Minoris, ω Draconis, α Ursæ Minoris, a Aurigæ, υ Sagittarii.

From 25 to 30 spectrograms of each of these stars are needed for determining the orbits. The observations of several of them are essentially complete, and the others are being observed as rapidly as circumstances will permit. An investigation of the orbit of η Aquilæ, based on all the available data, has been made by Mr. Wright, who has also partially computed a set of tables for facilitating the reduction of spectroscopic observations.

Two of the stars in the above list are of special interest. In the case of Polaris the velocity in the line of sight has a double period; a short oscillation, having a range of four miles per second and a complete period of 3 days 23 hours, is superposed on a much longer one, the period of which has not yet been determined, though it is probably as much as several years. The star is therefore a part of a triple system, two of the bodies being dark. Capella, or α Aurigæ, has a double spectrum. The two sets of lines undergo a periodic relative displacement.

To aid in the observations and reductions in this important part of the Observatory's work another assistant is greatly needed. It is a severe strain on both the present observers to keep the work in as satisfactory a state as it is at present.

A special study by Professor Campbell of the triple hydrogen lines in the spectrum of o Ceti led to many interesting results.

The 36-inch telescope has also been used for other spectroscopic investigations. The spectra of all sufficiently bright comets have been photographed by Mr. Wright. Observations of nebular spectra have been made by the Director and others. A comparison of the spectrum of hydrogen in a Geissler

tube with the spectrum of hydrogen in the Orion Nebula, by methods devised by Messrs. Campbell and Wright, led to some interesting results, which have been published, with other spectroscopic papers, in the *Astrophysical Journal.*

For the remaining half of the time the telescope has been used for micrometric work by Professor Hussey, Mr. Perrine and Mr. Aitken, and occasionally by other observers. Series of observations of the satellites of Neptune and Mars have been made by Professor Hussey; of the satellites of Neptune and Uranus by Mr. Aitken. One hundred and fifty sets of measures of planetary nebullæ, for parallax, and a set of measures for determining a possible refractive effect on stars by the head of Swift's comet, have been made by Mr. Perrine.

The 36-inch telescope is also used for the observation of comets, and sometimes, particularly in the case of expected comets, for purposes of discovery. Thus Wolf's periodic comet was discovered by Professor Hussey, and Temple's second periodic comet and Holmes' periodic comet were discovered by Mr. Perrine, with this telescope. In the course of his cometary observations Mr. Perrine has found one close double star and about thirty new nebulæ. The formation of a second nucleus in the head of Swift's comet was also discovered by him on May 11th.

Double stars are regularly observed with the 36-inch telescope, but they will be considered in connection with the smaller (12-inch) instrument.

THE CROSSLEY THREE-FOOT REFLECTOR.

After many experiments, changes and minor improvements, this telescope has been brought into excellent working order. It is in the personal charge of the Director, who is assisted by Mr. H. K. Palmer. It will be used for various astrophysical researches, and more particularly for the photography of nebulæ, for which purpose it has proved to be admirably efficient.

Some of the improvements which have been made are as follows: The pier has been cut down two feet, greatly increasing the facility with which the instrument can be handled. A new and powerful driving-clock has been made by the Observatory instrument maker, from designs by Professor Hussey. The double-slide guiding apparatus and the slow motions have been repaired and improved, and electric illumination provided for the former. Wires for electric lighting and for telephone communication have been run to the main Observatory. The study and the photographic room have been fitted up in a convenient manner for work. A very rigid declination clamp has been added to the mounting. The observing slit in the dome has been fitted with an adjustable wind-screen, on the general plan of the one used at the Yerkes Observatory.

The interior walls of the dome have been painted bright red; the inner surface of the dome itself, black. By means of a large red lamp on a movable stand, the interior is sufficiently lighted for the convenience of the observers, without danger of fogging the sensitive plate. These precautions are necessary, because the 'tube' of the Crossley reflector is merely a framework of iron rods, which does not exclude the light like the tube of an ordinary telescope.

Observation with the Crossley reflector is subject to more limitations than observation with the other instruments. Work cannot be pursued on moonlight nights, in slightly foggy, or even in damp weather. Nevertheless, about 70 photographs have been made of 40 different nebulæ and star-clusters, mostly with long exposures of from three to four hours each, and from the most interesting of these, positive enlargements have been made on glass. The definition of these photographs, and the amount of

detail shown by them, are surprising. Many new features are shown, and some general conclusions of the highest interest have already been drawn. From one to sixteen new nebulæ have been found on nearly every plate exposed, and I have estimated that the number of new nebulæ in the sky, within reach of the Crossley reflector, may be something like 120,000. A set of photographs made with the Crossley telescope was exhibited at the conference of astronomers recently held at the Yerkes Observatory, and has since been presented to the Royal Astronomical Society.

An investigation in the distribution of stars in the Great Cluster in Hercules, by means of a photograph taken with the Crossley telescope, has been made by Mr. Palmer.

Following a method which I proposed some years ago, the Crossley telescope has been used to produce photographs of the Great Nebula in Orion, by means of the less refrangible rays of the spectrum, which are directly comparable with drawings. The results are in confirmation of earlier spectroscopic observations made here, and may be regarded as an extension of the spectroscopic method to parts of the nebula which are too faint for visual observation.

THE TWELVE-INCH REFRACTOR.

This instrument is in charge of Professor Hussey, who is assisted by Mr. Coddington. A most important part of its work, as well as that of the 36-inch telescope, is the measurement and discovery of double stars, for which purpose the conditions on Mt. Hamilton are especially suitable. Professor Hussey is at present engaged in the remeasurement of all the Otto Struv stars, or double stars discovered at the Pulkowa Observatory. About 2,000 measures have been made in connection with this work up to the present time.

The number of measures of double stars made during the past year is as follows: By Professor Hussey, 996; by Mr. Aitken, 976. Mr. Aitken's list includes nearly all the rapid binary systems.

A systematic search for new pairs has been made by Professor Hussey, mainly with the 36-inch refractor, within the zone 10° to 14° south declination. Thirty-six new pairs were found during the past year, most of them very close, the distance in two cases being only 0.″15.

The zone between 2° and 10° south declination has been examined in a similar manner, with the the 12-inch equatorial, by Mr. Aitken. About 50 pairs have been found since April 1st of the present year. To guard against errors, each new pair has been examined with the 36-inch telescope on at least one night. Only close stars brighter than the 9th magnitude are included in these lists.

With both equatorials the following complete sets of comet observations have been made during the year ending September 1, 1899:

Comet.	*No. Obs. and Observer.*
1898, I. (Perrine).	21, Perrine.
1898, IV. (Wolf).	8, Hussey.
1898, VII. (Coddington)	9, Coddington.
1898, VIII. (Chase).	1, Aitken, 36 Coddington.
1898, IX. (Perrine).	20, Perrine.
1898, X. (Brooks).	19, Hussey.
1899, a (Swift).	7, Hussey; 17, Perrine.
1899, b (Tuttle).	13, Perrine.
1899, c (Tempel II.).	2, Hussey; 10, Aiken. 31, Perrine.
1899, d (Holmes).	5, Aitken; 9, Perrine.

Total number of comet observations, 208.

At the request of Professor Simon Newcomb, the asteroids discovered by Professor James C. Watson have been observed for the National Academy of Sciences. The work has been done by Mr. Coddington. In general, ephemerides were computed from the data given in the *Berliner Jahrbuch*. The region indicated by the ephemeris was photographed with an exposure of one hour

or more with the Willard 6-inch lens, and the asteroid identified on the negative by the trail caused by its proper motion. It was then observed with the 12-inch telescope. All but two of the Watson asteroids (or three, counting the one that is 'lost') have been rediscovered and observed in this way. From three to five observations have been made of each. In the course of the work Mr. Coddington discovered two new asteroids; (439) Ohio, and (440).

Thirty-seven observations of ten other asteroids have been made by Mr. Coddington, seventy-nine observations of five asteroids by Professor Hussey (including sixty-five observations of the new planet Eros), and ten observations of two asteroids by Mr. Palmer.

THE 6½-INCH MERIDIAN CIRCLE AND THE 4½-INCH TRANSIT INSTRUMENT.

The Meridian instruments are in charge of Professor Tucker, who is assisted by Mr. Crawford. The transit instrument has been little used, as the clock corrections for the time-service have been furnished by the meridian circle.

During the year ending September 1, 1899, 6,000 observations on 106 nights have been made with the meridian circle, mostly of southern stars from the catalogue of Piazzi. In addition to these, observations for a study of the refraction were made during two months by Mr. Crawford, who has also been regularly employed in computation. The reductions have been carried through the early stages for all the observations of the Piazzi stars, and have been completed for about 1,000 observations. A few miscellaneous observations of comparison stars and asteroids have also been made.

The manuscript of the meridian circle results from 1893 to 1896, forming volume IV. of the Publications of the Lick Observatory, has been sent to the State Printing Office.

THE CROCKER PHOTOGRAPHIC TELESCOPE (SIX-INCH WILLARD LENS).

This instrument, in charge of Mr. Coddington, has been employed mainly in the re-discovery of the Watson asteroids. Photographs have also been made of nebulæ, and of comets 1899, a (Swift) and 1898, X. (Brooks).

THE FLOYD TELESCOPE, AND SIX-INCH PORTRAIT LENS.

These two instruments, which are carried by the same equatorial mounting, have been in charge of Mr. Palmer, who has employed them, at such times as could be spared from other duties, in photographing the extended nebulosities of Herschel; also, in photographing other nebulous regions, in connection with the work of the Crossley reflector. Photographs were also made of comet 1899, a (Swift), and 1898, X. (Brooks).

THE BRUCE 6½-INCH COMET SEEKER AND THE 4-INCH COMET SEEKER.

The comet seekers, in charge of Mr. Perrine, have been constantly employed. For two months during the past summer they were used by Mr. Crawford.

The comets discovered at Hamilton during the year ending September, 1, 1899 were

Comet, 1899, IX. (Perrine), September 12, 1898.
Comet, 1899, c (Tempel, II.), Perrine, May 6, 1899.
Comet, 1899, d (Holmes), Perrine, June 10, 1899.

In the year ending September 1, 1898, six comets were discovered at Mt. Hamilton.

THE PHOTOHELIOGRAPH.

Two photographs of the sun are taken with this instrument every clear day, and the negatives are stored for future reference. The work has been done by Mr. Pauli, the Janitor.

THE SEISMOGRAPHS.

The seismographs, in charge of Mr. Perrine, are always kept in adjustment. A

spare seismograph has been loaned to the U. S. Observatory at the Mare Island Navy Yard, on the condition that records and reports of earthquake shocks shall be sent to Mt. Hamilton. Several observers, mostly in the neighborhood of San Francisco, also kindly send reports. The collected results are published yearly by the U. S. Geological Survey.

METEOROLOGICAL INSTRUMENTS.

Meteorological observations are made three times daily. Monthly summaries are furnished to the U. S. Weather Bureau. The daily records of the self-recording instruments are filed for future reference.

The time-service has been conducted as heretofore.

MISCELLANEOUS OBSERVATIONS AND COMPUTATIONS.

The Leonid meteors were observed and chartered by several members of the Observatory staff in November, 1898. The results were sent to Harvard College Observatory for discussion in connection with other data.

The reduction of Professor Schaeberle's meridian observations has been in the hands of Mr. Aitken. During the year the Right Ascension and Mean Place reductions were completed, the separate observations made in each year were collated and the discrepancies removed. The Coast Survey stars were reduced to the epoch 1880, the observations of different years collected, and the final places checked by comparison with other catalogues. The Struve stars are now being reduced to the epoch 1880, and the entire work will be completed during the present year.

Two orbits and ephemerides for comet 1898, IX. (Perrine), were computed by Mr. Perrine.

Elements and ephemerides for comet, 1898, V. (Giacobini), and for comet, 1898, X. (Brooks), and elements for comet, 1899, a (Swift) were computed by Professor Hussey.

The definitive orbit of comet, 1896, III. (Swift), was computed by Mr. Aiken.

An orbit and ephemeris for comet, 1898, VIII. (Chase), were computed by Mr. Coddington and Mr. Palmer.

A computation of the definitive elements of comet, 1897, III. (Perrine), is being made by Mr. Palmer.

Orbits and ephemerides of the new asteroids (439) and (440), and ephemerides for most of the Watson asteroids, were computed by Mr. Coddington.

Two sets of elements for the planet Eros, and circular elements of the asteroids (439) and (440), were computed by Professor Hussey.

Announcements have been telegraphed to Harvard College Observatory, for distribution, at various times.

Measurements of the wave-lengths of lines in the spectre of third type stars, and of the positions of nebulæ on plates taken with the Crossley Reflector, have been made by Mr. Palmer.

A report on the Crocker Eclipse expedition to India is being prepared by Professor Campbell. * * *

JAMES E. KEELER.

LICK OBSERVATORY.

THE EARLY PRESIDENTS OF THE AMERICAN ASSOCIATION.

II.

AMONG our honorary fellows is the name of one who was not only a founder* of the Association of American Geologists in 1840, but also a founder of our own Association,

* The following quotation concerning the formation of the Association of American Geologists is given in a sketch of Professor James Hall, accompanied by an engraved portrait on wood that appeared in the *Popular Science Monthly*, Vol. XXVI., p. 122, November, 1884: "The comparison of observations and interchange of views led to the opening of correspondence,

and until the meeting of the American Association in Boston last year, our senior past president. I refer, of course, to that Nestor of American geologists, James Hall. It was but natural that he should be called to preside over the meeting in the city of his chosen residence. The second Albany meeting was held late in August, in 1856, and must ever remain a memorable one in the annals of American science on account of the inauguration of the Dudley Observatory at that time. It is no purpose of mine to consider the unfortunate controversy that followed that event, involving as it did the names and reputation of four great presidents of our Association—Henry, Bache, Pierce and Gould, but no student of the history of American science can well ignore its existence.

HALL.

Hall was born of English parents in Hingham, Massachusetts, in September, 1811, and after the usual schooling was about to prepare himself for the medical profession, when in 1831 his interest turned toward natural science and he entered the Rensselaer School in Troy, where he was graduated in 1832. It was there that he came under the influence of Amos Eaton, and, like Torrey, profited by it. His connection with the Rensselaer Polytechnic Institute did not cease on graduation, for he was made an assistant, and later became professor of geology, which chair he retained until 1876, when he was made *emeritus*. Thus his loyalty to his *alma mater* continued for nearly seventy years, and was only severed by his death.*

His real life-work, however, was in connection with the Geological Survey of New York, which was organized and divided into four divisions in 1836. Hall was made an assistant geologist and assigned to the second division under Ebenezer Emmons. A year later he was appointed one of the State geologists, and assigned to the charge of the fourth district. He began his explorations in the western part of the State, and from 1838 to 1841 prepared the annual reports of progress in the work of his district. His final report, issued in 1843, as Geology of New York, Part IV., contains, according to T. Sterry Hunt, a description "in a very complete and exhaustive manner the order and succession of the strata, their mineralogical and lithological characters, and the organic remains which they contain."†

Retaining the title of State Geologist, he was in 1843 given charge of the paleontological work of the State survey, and the results of his many years of study have been given to the world in the thirteen volumes of the Natural History of New York, which bear the subtitle of Paleontology. These volumes have received the well-deserved encomium of being "the most comprehensive work of the kind which any state or country in the world possesses." ‡

The first appropriation—$15,000—that was made for this work was with the understanding that it should be completed for that sum, but again and again as the work progressed Hall appealed to the legislature for additional funds for its completion, until in 1894, it was estimated that the entire

by a formal resolution of the New York Board, with other geologists, especially with those engaged in State surveys, of which several were then in progress. This correspondence led to an agreement for a meeting of geologists in Philadelphia in the spring of 1840, and this assemblage, of less than a score of persons, led to the organization of the Association of American Geologists, which, at a later period, on the occasion of its third meeting, added the term Naturalists; and, finally by expanding its title, it became the American Association for the Advancement of Science."

* Biographical Record of Rensselaer Polytechnic Institute.

† T. Sterry Hunt in the American Cyloprædia, Vol. VIII., article James Hall.

‡ *New York Times*, August 9, 1898.

work had cost the State over $1,000,000. His comprehensive studies on the paleontology of New York naturally demanded researches beyond the limits of the State, and these he extended westward to the Rocky Mountains. It is now generally admitted that his investigations 'have served as the basis of all our knowledge of the geology of the Mississippi Basin.'*

In 1855 he was offered charge of the paleontology of the Geological Survey of Canada, with the promise of succeeding Sir William E. Logan as director on the retirement of the latter. When he was about to accept, promises of more liberal appropriations from the legislature of New York, and the influence of many leading American scientists, including Louis Agassiz and James D. Dana, led to his declining the offer, a decision which as the promises were never realized, he came to regard as 'the great mistake of his life.'†

The splendid work which he did in New York led to the request for his services elsewhere, and he was appointed to the charge of the Geological Survey in Iowa, in 1855, and to that of Wisconsin in 1857, preparing reports on both of these surveys. The paleontology of several government exploring expeditions was referred to him for discussion, notably that of Frémont, that of Stansbury, that of the Mexican Boundary Survey, and that of King's exploration of the fortieth parallel.

In 1866 the New York State Museum was reorganized, and Hall was made director, a place which he then held until 1893, retaining, however, until his death, the office of State Geologist. It was at our Buffalo meeting, in 1896. that special commemoration exercises were held in honor of the sixtieth anniversary of Hall's connection with the Geological Survey of the State of New York, and at that time papers were read descriptive of his work. W J McGee described him as the 'founder of stratigraphic geology and applied paleontology in America.'* Referring to Hall's study of the crystalline stratified rocks he also said: "It is not too much to say that the method was established by the New York Survey, and that it finds its best illustration in the classic fourth district; here it was that American stratigraphic geology was founded."†

It was also Hall, who, according to Hunt, "laid the grounds for a rational theory of, mountains, which must be regarded as one of the most important contributions to geological science."‡

He died in August, 1898, and the "monument of the man himself is builded in the rocks of New York, a monument more enduring than bronze or gold."§

Our Association is not local to the United States, but American, and at its tenth meeting it was decided to hold the gathering, in 1857, in Montreal, Canada. For president of that meeting Jacob Whitman Bailey was chosen, but early in the year he died, and the vice-president filled his place.

BAILEY.

Bailey was born in Auburn, Massachusetts, and, after a common school education, he entered the United States Military Academy, where he was graduated in 1832. He joined the artillery branch of the service, and for several years was stationed at various army posts. An early fondness for natural science was assiduously cultivated during these years, and he soon returned to West Point, where he was given charge of

* T. Sterry Hunt in the American Cyclopædia. See note 2, p. 20.

† Biographical Record of Rensselaer Polytechnic Institute.

* Science, New Series, Vol. IV., p. 706.

† Idem, p. 702.

‡ American Cyclopædia, Vol. VIII. See note 2, p. 20.

§ Benjamin K. Emerson in Science, Vol. IV., p. 717.

the chemistry, mineralogy, and geology, and later became professor of these branches, an appointment which he then held until his early death.

Bailey was one of the very first in this country to apply the microscope to the study of minute forms of life, and his work on infusorial fossils and the algæ gained for him a high place among contemporary scientists. He was a pioneer on the examination of the deep-sea soundings made by the United States Coast Survey, and his report on that subject is given in one of the early volumes of the Smithsonian Contributions to Knowledge. This series of publications also contains his papers on terrestrial microscopical organisms. His name is associated with many improvements in the construction of the microscope, and the indicator devised by him is one of his most valuable contributions to science.

He died too soon, but not until his work had 'won the approval of naturalists throughout the world.'*

The vacancy created by the death of President Bailey was filled by Alexis Caswell, who was the first vice-president of the Association. It is a matter of record that "he sustained the credit of his country on a foreign soil by his dignified presence and his manly eloquence to the great satisfaction of his associates."†

CASWELL.

Caswell was born in Taunton, Massachusetts, in 1799, and his ancestors were among the first settlers in that place. His paternal grandmother was a direct descendant of Peregrine White, who was born on the Mayflower in 1620. He was graduated at Brown University in 1822, standing first in his class, and then passed to Columbian University in Washington, where for five years he taught both the classics and mathematics. It was in Washington that he made his special studies in theology under the direction of Dr. William Staughton, President of the University.

In 1827, having resigned his chair, he became pastor of the Baptist congregation in Halifax, Nova Scotia, but a year later he relinquished that charge to return to Providence on an invitation from the First Baptist Church there. The chair of mathematics and natural philosophy in Brown becoming vacant, it was at once tendered him, and promptly accepted. For thirty-five years he continued in charge of the scientific instruction in the college of his choice, and then after a few years' rest he was chosen its president, which place he held until 1872, when, on the fiftieth anniversary of his graduation, he resigned.

It was the development of the various departments of science in Brown University that gave Caswell his high reputation among his contemporaries, but he had other claims that were also worthy of recognition. During the winter of 1858–59 he delivered four popular lectures on Astronomy before the Smithsonian Institution that were deemed of such importance as to warrant their insertion in the annual report of that year. His contributions to the young science of meteorology were of permanent value. Beginning with the year 1831, he instituted a series of observations in Providence which he continued until 1868, that were "precise as regards temperature and pressure; and including also much information on winds, clouds, moisture, rain, storms, the aurora," etc.*

I have spoken of his career as a teacher, and I have referred to his contributions to science. In closing this brief sketch it must be added that he was prominent in many walks of life, taking ever an active interest

*Smithsonian Report for 1857, p. 74.

†Memorial of Alexis Caswell, D.D., LL.D., with an engraved portrait on steel, p. 29, being a reprint of the Memoir by Joseph Lovering, presented before the American Academy of Arts and Sciences.

*Joseph Lovering in Memoir, p. 27.

in the welfare of his fellowmen. "In every charitable movement he was foremost with practical advice and generous aid."*

"Few men have filled more eminent positions in the walks of learning and science, and few pass away more cherished in scholarly remembrance than Alexis Caswell."†

WYMAN.

The twelfth meeting of our Association was held in Baltimore, and over that gathering Jeffries Wyman, of Boston, was chosen to preside, but when the time for the meeting came Wyman was unfortunately absent in South America. John E. Holbrook, of Charleston, South Carolina, the vice-president, was likewise unable to be present, and the duties of presiding again fell upon the competent shoulders of Caswell.

Wyman‡ was born in Chelmsford, Massachusetts, in 1814. He was the son of a physician, and after graduating from Harvard in 1833, followed in the footsteps of his ancestors, and with his brother, who still lives, studied medicine, both taking their degrees in 1837. Boston became his home, and several minor appointments came to him, notably, a course of lectures on comparative anatomy at the Lowell Institute, with the proceeds of which he visited Europe, where for two years he studied anatomy under the best masters both in Paris and London.

In 1843 he returned to Boston and soon was appointed to the chair of anatomy and physiology in Hampden-Sidney College, in Richmond, Virginia. The duties of this appointment called him from Boston during the winter and spring months only, and so offered a pleasant change from the rigors of the severer weather in Boston. Five years later he was called to succeed the celebrated John C. Warren in the Hersey chair of anatomy in Harvard Medical College, a congenial post, which he filled with honor until his death.

It would require more knowledge than I possess to properly present to you abstracts of the magnificent memoirs on comparative anatomy that came from the pen of this leader in science. That task, fortunately for the world, has been performed by one who studied with him, and to the memoir presented before the National Academy of Sciences* by Packard, I beg to refer you for that full and adequate treatment which Wyman's work deserves. Two quotations may, however, be given to indicate their value. His study on the gorilla, according to Gray, 'assured his position among the higher comparative anatomists.'† His paper on the bull frog was described as the 'clearest introduction to the most complex of animal structures.'‡

So great was his knowledge of anatomy that a single sentence from Oliver Wendell Holmes sums up fully his remarkable ability to develop a structure from a single bone.

"In a memorial trial [he says] his evidence relating to the bones which had been submitted to great heat is of singular excellence as testimony, and his restoration of fragments is a masterpiece of accuracy and skill."§

Wyman was a man of delicate constitution, and as he advanced in years it became his settled custom to spend the winters in Florida. It was in that land of flowers that he began his archeological work by

*New York Tribune, Jan. 9, 1877.

†Taunton Gazette, January 9, 1877.

‡ Biographical Memoirs of the National Academy of Sciences, Washington, 1886. Vol. II., p. 75. Jeffries Wyman, by A. S. Packard. See also *Popular Science Monthly*, Vol. VI., p. 355, where an engraved portrait on wood is given; also see Anniversary Memoirs of the Boston Society of Natural History, Boston, 1880, where a lithograph portrait is given.

* Biographical Memoirs, Vol. II., p. 77.

† Idem, p. 97.

‡ Jeffries Wyman, Memorial Meeting of the Boston Society of Natural History, October 7, 1874, p. 24.

§ Biographical Memoirs, p. 95.

the examination of the shell heaps, then little known, but now recognized as existing at many places along our Atlantic coast. These he studied with much interest and prepared reports on them which were published by the Peabody Museum in Cambridge. Of this institution he was one of the founders and its first curator. His successor and the second curator of that institution, I need hardly add, is President Putnam.

For the meeting in the year 1859 the City of Springfield, Massachusetts, was chosen, and to preside over that gathering Stephen Alexander, of Princeton, was selected by his colleagues.

ALEXANDER.

Alexander was born in Schenectady, New York, in 1806. As a boy he was slender and delicate, fond rather of books than of outdoor sports, and being an excellent student, he was given a college education. He was graduated at Union in 1824 with high honor, although only eighteen years of age. For several years he taught, and then made astronomical observations in Albany, the results of which were communicated to the Albany Academy.

In a sketch * by his successor at Princeton, the inference is made clear that the marriage of his sister in 1830, to Joseph Henry, had much to do with the shaping of his scientific career, for he followed Henry to Princeton in 1832, and then entered the Theological Seminary as a student.

His scientific work was entirely connected with astronomy, and, beginning with 1834, he observed most of the solar eclipses visible in the United States. In 1860 he was made chief of the party that went to Labrador under the auspices of the United States Coast Survey to observe the eclipse of that year, and again, in 1869, he was a leader of the observation party sent to Ottumwa, Iowa. He was associated with Henry in his thermopile observations on sun spots in 1845, as well as in other astrophysical researches, and, to quote from Young:

"He observed four transits of Mercury, and in December, 1892, he closed the record of more than fifty years by a careful and satisfactory observation of the transit of Venus." *

It would be too much to claim that Alexander was a great scientist, but fifty-three years of earnest devotion to his professional duties, added to his valuable contributions to the science of his choice, is a career worthy of high honors. It was well said of him at the time of his death, in 1883, that "American astronomy to-day owes much to his life and labors." †

The unwritten law of alternating the succession in the presidential chair from a representative of the physical sciences to one devoted to natural science received an emphatic demonstration in the selection of Isaac Lea as the successor of Alexander. The searcher for truth in the remote distance of far-away skies gave place to the patient student of fresh-water shells.

LEA.‡

Born in Wilmington, Delaware, in 1792, Lea was early influenced towards a fondness for natural history by his mother, who was devoted to botany. At the age of fifteen the boy was sent to Philadelphia to enter mercantile business, and there met Lardner Vanuxem, the future geologist. The young men spent their leisure in long walks, in which they collected minerals and studied the geological features of the vicinity.

* Biographical Memoirs of the National Academy of Sciences, Washington, 1886, Vol. II., p. 249. Stephen Alexander, by Charles A. Young.

* Biographical Memoirs, p. 254.

† Idem, p. 259.

‡ A Portrait of Isaac Lea is published as a frontispiece.

Then they learned of the Academy of Natural Sciences, and the influences of that institution which had been exerted for so much good among the young men in Philadelphia, was extended to them. Membership was accorded to them in 1815, and two years later Lea presented his first paper before that body.

His interest in mineralogy gradually extended to geology, and especially to paleontology, through which he acquired a special fondness for fresh-water and land shells, to the study of which he devoted first his leisure from business and then all of his time. The unios were specially attractive to him, and his first conchological paper, published in 1827, was a description of six new species of that genus.

From this beginning grew his many papers on that particular mollusk until his separate articles collected under the title 'Observations on the Genus Unio,' 1827–1874, formed thirteen quarto volumes, containing two hundred and eighty plates. Besides the foregoing, he wrote many papers on new species of the Strepomatidæ, Colimaceæ and other forms, indeed, it has been computed that nearly two thousand new species were described by him, of which nearly one-half were unios. His entire bibliography includes almost three hundred titles.

To the few specimens originally collected for study were soon added others that were sent to him from all over the world, and his cabinet, unique of its kind in the world as far as the unios were concerned, was bequeathed by him to the United States National Museum. As a memorial to him it fills the large hall of the Smithsonian Institution, and to students the fruits of his years of devotion to science are ever available, thus carrying out in a practical way the injunction of Smithson's bequest to found an institution for 'the increase and diffusion of knowledge.'

Lea's first love of minerals also followed him through life, and he formed a valuable collection of gem stones. These, like his larger cabinet, have found a permanent home in the National Museum. His special interest in connection with gems was concerning inclusions in crystals, and upon this subject he contributed a number of valuable papers.

The Academy of Philadelphia chose him as its president, in 1858, and two years later he became president of our Association. He lived until 1886, and continued his interest in science until the last. One of the features of the Philadelphia meeting of 1884 was the reception given by Lea to the visiting scientists, both from our own Association and from the British Association, at his summer home.

The long struggle of cruel warfare between the North and the South prevented any meeting of our Association for five years subsequent to the gathering in Newport, and so it was not until 1866 that the members of the American Association were reunited in a meeting held in Buffalo. It was a happy coincidence that for that occasion a president had been chosen in 1860, who at that time was one of the most famous of southern scientists, and who, in consequence of the fortunes of war, turned his steps northward to win even greater laurels as president of Columbia University. I refer, of course to Frederick Augustus Porter Barnard, the selection of whom did credit alike to the men of science, whether from the north or from the south.

BARNARD.

Barnard was born in Sheffield, Massachusetts, in 1809, and his ancestors settled in New England early in its history.* As a

* See Memoirs of Frederick A. P. Barnard, D.D., LL.D., tenth president of Columbia College, by John Fulton, New York, 1896. Also *Popular Science Monthly*, Vol. XI., p. 100, and *Scientific American*, Vol. LVIII., p. 327, May 25, 1889, both of which contain portraits.

boy he learned the printer's art, but not to the neglect of his studies, for he was graduated at Yale in 1828, standing second in his class. At once he began his work as a teacher in the Hartford grammar school, and also took up in Hartford the study of law under Jonathan Edwards. Two years later he returned to New Haven and was made a tutor of mathematics. At that time a severe illness produced a temporary deafness, and as that affliction was hereditary in his family, it led him to retire from Yale and to turn his attention to the education of the deaf and dumb, accepting first a call in an institution in Hartford, and in 1832 to one in New York City.

In 1837 he was invited to the University of Alabama, where he filled, first the chair of mathematics and natural philosophy, and later that of chemistry and natural history, remaining in Tuscaloosa until 1854. It was said of him, at that time, that he was "the best at whatever he attempted to do; he could turn the best sonnet, write the best love story, take the best daguerreotype picture, charm the most women, catch the most trout, and calculate the most undoubted almanac."* As further evidence of his versatility it may be mentioned that he edited two newspapers of opposite political opinions. It was also while in Tuscaloosa that he delivered his famous Fourth of July oration, beginning "No just cause for a dissolution of the Union in any thing that has hitherto happened; but the Union is the only security for Southern rights." While it enraged his colleagues greatly, "this oration, read in every part of the State, as it was within a week, presented the northern cause in an entirely new light in Alabama, and checked the rising spirit of rebellion for many years."†

* Appleton's Annual Cyclopædia, Vol. XIV., p. 73. This was given me originally by Mrs. Barnard.

† Clipping from *The New York Tribune*, probably of July 6, 1886.

In 1854 he accepted a call to the chair of mathematics, natural philosophy and civil engineering in the University of Mississippi, of which institution he became president in 1856, and chancellor in 1858. When the Civil War closed the doors of that University he declined office under the Confederate government and came north. For a time he was connected with the United States Naval Observatory, and also with the United States Coast Survey, but the vacant chair of physics in Columbia College attracted him, and the trustees of that institution were wise in taking advantage of their opportunity to offer him the higher honor of the presidency of Columbia College, a place from which President King had just resigned.

Newberry, who for so long was closely associated with him, in an admirable address, in which he presented a summary of Barnard's career as an educator, said of the growth of Columbia during his presidency:

"He made there a noble and an honorable record. Every one of the steps of progress was either conceived or earnestly advocated by him and owed its achievement to his support. He was not only a participant, but a leader in every forward movement."*

In conclusion let me quote the lines that his friends Whittier wrote of him:

> Rich, from life-long search
> Of truth, within thy academic porch
> Thou sittest now, lord of a realm of fact,
> Thy servitors the sciences exact;
> Still listening with thy hand on Nature's keys.
> To hear the Samian's spheral harmonies
> And rhythm of law.

As I approach that period in the history of our Association during which it has been my privilege to know personally the men who were our leaders, the pleasure of pre-

* John S. Newberry. Necrology Report of the University Convention of the State of New York. (Reprint.)

paring this address increases. Barnard was president of Columbia during my undergraduate course there, and perhaps the last time that I saw him was on the occasion of the meeting of the American Association in New York, 1887. Another meeting was yet to come and go, and then Barnard too was called away to join the silent majority.

In that admirable ad[illegible]ss with which he welcomed the Associat[illegible] to Columbia he reviewed the labors of his many distinguished predecessors in the Association, saying in conclusion:

> All these have gone to their rest, many of them full of years, all of them full of honors. Others have risen to fill their places, no less earnest, no less capable, and destined to be no less illustrious.*

NEWBERRY.

Among all of these there is none of whom I am prouder on this occasion and in this place to express my love and honor for than John Strong Newberry, of whom it was so well said:

> He is a geologist—keen of eye, stout of limb, with a due sense of the value of detail, but with a breadth of vision that keeps detail in due subordination.†

Newberry‡ was born in Windsor, Connecticut, towards the close of the year 1822. He was of early New England ancestry, and was specially proud of the fact that his grandfather was an officer in the American army during the war of the Revolution. The boy was barely two years old when his parents moved to Ohio and Cuyahoga Falls became his home. He was educated at Western Reserve College, and received his doctor's degree from the Cleveland Medical College in 1848, after which he spent two years in special study abroad.

Then settling in Cleveland he began the practice of medicine, but his love for natural science was greater than his fondness for his profession, and in 1855 he accepted an appointment in the United States Army as assistant surgeon. From that time until 1861 he served both in his professional capacity and as a geologist to exploring parties. At first under Williamson who was sent to examine the country between San Francisco and the Columbia River; then under Ives in his exploration of the Colorado River; and finally under Macomb with the expedition sent to study the San Juan and upper Colorado rivers. On the material gathered during each of these expeditions he prepared valuable scientific reports, which were published by the government. In these volumes will be found pioneer work of great value, much of which has been lost sight of on account of the greater development of the same territory by subsequent expeditions. In an appreciative sketch of him by Kemp, his successor at Columbia, that appeared at the time of his death, I find this statement:

> His determinations of strata in the west, although based on the hasty itineraries of exploring parties, have been very generally corroborated by later and more deliberate work.*

His wonderful 'ability to grasp as by intuition the bearings of many widely separated facts,'† would have gained even greater renown for his early work in the west, had not the civil war intervened.

From 1861 to 1866 Newberry was secretary of the Western Department of the United States Sanitary Commission with

* Proceedings, American Association for the Advancement of Science, Vol. XXXVI., p. 342.

† Address made at the presentation to Newberry of the Murchison medal in 1888, by the Geological Society of London. He was the first American geologist to receive that honor.

‡ See sketch in *Popular Science Monthly*, Vol. IX., p. 490, August, 1876, with an engraved portrait on wood, and also *Scientific American*, December 31, 1891, with half-tone portrait.

* In Memorium. Professor John Strong Newberry, *School of Mines Quarterly*, Vol. XIV., p. 90, January, 1893, with two engraved portraits on steel.

† Idem, p. 99.

supervision of all the operations of that body in the valley of the Mississippi. He organized the comprehensive work of the commission in the large section that was entrusted to his care, and during its life expended more than $800,000 in money, besides distributing hospital stores that were valued at more than $5,000,000. The whole story of that wonderful achievement, its development, and its completion was told by himself in his report of the commission in the valley of the Mississippi that was published in 1871.

With the return of peace came a new interest in the development of our institutions of learning, and conspicuous among the newer experiments was the then recently organized School of Mines of Columbia College. It was the first institution of its kind in the United States, and its success was yet to be determined. Newberry was called to the charge of the department of geology in the new school, and, with a faith in its ultimate success that never faltered, he accepted the trust. With the same genius for organization that was shown by his development of the work of the Sanitary Commission, he began the planning of courses of study. Alone he gave instruction in botany, zoology, geology, lithology, paleontology and economic geology, and a quarter of a century later left to the world as his best and greatest memorial a magnificently equipped department of the special branches taught by him not excelled by any similar educational institution in this country. Nor was this all. He created a museum of over 100,000 specimens, principally collected by himself, which served to illustrate his lectures on geology and economic geology. It contains "the best representatives of the mineral resources of the United States to be found anywhere, as well as many unique and remarkable fossils." *

* This is his own description taken from a personal letter written to me in 1888.

Kemp calls it 'a monument to his memory,' and adds:

> Its wealth of fossil fish and fossil plants makes it unique and famous among geological museums.*

In 1869 he became State geologist of Ohio, and for many years he regularly spent his summers in the field, while the accumulated material was digested during the winter months in the laboratory in New York, yielding the nine large volumes of reports published by Ohio. The unwillingness of the State Legislature to permit the completion of the work as originally intended was the great grief of his closing years, and marked the beginning of his end.

It is a pleasure to remember that during the last years of his life he received the fossil plants and fishes from the United States Geological Survey to report on, and so returned to the study of those forms which, as a boy, he loved to collect in the coal deposits of eastern Ohio.

He was rich in those accumulated experiences that we call wisdom. He was a friend, faithful and true, as those who knew him can testify. He is gone, but his influence cannot die. It will live forever to 'reach through nature, moulding men.'

American astronomers hold a high place in the history of the development of their chosen science, and among those in our country who have made the study of the heavens their chief life-work, first place must unquestionably be given to Benjamin Apthorp Gould for his splendid achievements. In his time he ranked as the greatest of our astronomers, and our Association honored itself in choosing him to preside over the meeting held in Chicago in 1868.

MARCUS BENJAMIN.
U. S. NATIONAL MUSEUM.

(To be continued.)

THE BEST MOVEMENT FOR HANDWRITING.

IT is by no means certain that the ordinary writing movement, as taught in the

* *School of Mines Quarterly*, Vol. XIV., p. 99.

schools and used with more or less of individual peculiarity by most adults, represents, for purposes of rapid and legible writing, the best of which the human hand is capable. Every penman will recognize certain difficulties that attend the use of this movement. It is not as easy as one could wish: continued employment of it tends to writer's cramp. It is not as rapid as one could wish. It does not give as good penmanship as one could wish: it is subject to jerks and irregularities, and at high speeds requires so much exertion in making the vertical strokes that it is apt to degenerate into a flat scrawl.

In order to obviate some of these difficulties, another movement has been advocated and largely taught. This is sometimes called the 'American method,' sometimes the 'forearm movement.' In strictness, however, it is not a forearm movement, but a movement of the full arm from the shoulder. This mode of writing has at least one great advantage; it never leads to writer's cramp. It is not liable to cramp because it is made by good-sized muscles, whereas the ordinary thumb and finger movement is largely produced by the little muscles in the hand itself. The full arm movement has another advantage in the boldness and smoothness of its lines. But there is one strong objection to the use of this movement; the parts moved are much larger than is necessary for the end in view, and the amount of energy required is thus absurdly great. When this movement is hastened, it shakes the whole body. And besides this, it is not found to be specially favorable to the union of speed and legibility; it does not obviate the flattening out of the letters.

There is yet a third movement of which the hand is capable—a movement never taught for penmanship, but still possessing certain marked advantages over the movements now in vogue. It may be described as a side-to-side movement of the wrist—adduction and abduction. The forearm may also come into play, and the movement be made partly from the elbow. In order to write by this movement, let the top of a sheet of paper slant over to the right, instead of to the left as in ordinary writing. To carry the hand along the horizontal line, draw the whole arm, in the direction of the forearm, back towards the flank. Meanwhile impart to the wrist (and forearm) a back-and-forth, lateral motion, which shall produce the vertical strokes of the letters. Considerable awkwardness may at first be experienced, and the unusual position and appearance of the sheet will cause the writing to be 'back-handed.' This may be avoided by bending the elbow more sharply, so bringing the hand in rather close to the chest. The paper can then be placed square on the table, and the writing still made with the same movements, though less freely than in the other position. In order to compare the suggested movement with the others, we may reduce writing to its lowest terms, namely, to a series of simple up and down strokes, like a connected row of *m*'s. By the use of this simplified form, we can easily compare the three movements and observe their relative ease, speed and accuracy.

Extensive tests were made by this method,* and it was found that in point of speed the forearm movement averaged 23% better than either of the others. In point of freedom, likewise, it had the advantage, as was seen by the greater lengths of its vertical strokes when the movements were hastened. In regard to accuracy, several points had to be considered. In keeping the alignment, and in uniformity of height,

* This comparison was first suggested incidentally in the course of a study on the accuracy of movements, and the results are more fully reported in a paper entitled 'The Accuracy of Voluntary Movement,' published as Monograph Supplement, No. 13, to the *Psychological Review*.

the forearm movement proved slightly inferior to the more practiced finger movement, and even to the full arm movement. In this particular the full arm movement would, with practice, probably be the best of the three. But in uniformity of slant, the forearm movement was far superior to the others. There were a smoothness and grace in the tracings of this movement that were quite absent from the rest.

These analytical laboratory experiments were obtained with a high degree of agreement from a considerable number of individuals. As to the results of the suggested movement in actual writing, little more can at present be asserted than that the movement is entirely practicable. The few who have tried it are pleased with the results. The writer of this article has himself adopted it largely, and finds realized the advantages that the laboratory experiments gave reason to expect. Rapid writing is freer and more legible, showing no tendency to degenerate into the flat scrawl. Less fatigue is felt; and the muscles employed, though not so large as those of the full arm movement, are large enough to avoid the tendency to cramp. The uniformity of slant gives the page a neat appearance. The alignment is satisfactory. The possession of two movements is at times a great source of comfort. Finally, from the relative facility with which the left hand was found to acquire the various movements, as well as from the fact that the wrist movement is made by the simplest muscular coördination, it seems altogether probable that the wrist movement would possess, over the complex finger movement, the advantage of being more easily learned.

R. S. WOODWORTH.

A CENSUS OF THE FOSSIL VERTEBRATA OF NORTH AMERICA.

THE writer has been able to make such an examination of the literature appertaining to fossil vertebrates, that he feels justified in making a statement regarding the number of genera and species which are known to occur in North America north of Mexico. The writer is not aware that any one else has yet prepared a list of the species of all the groups, and apparently the paleontologists themselves have very vague ideas regarding the number of known species, outside of the groups which they are themselves studying.

It is, of course, recognized that no two men in preparing such a list would arrive at the same results, since their ideas would undoubtedly differ more or less regarding what are to be considered tenable genera and species. In determining whether or not reputed species are to be reduced to synonymy, the writer has in most cases accepted the results of the investigations of other workers, where such results have been expressed clearly and definitely; while in cases of doubt a conservative course has been followed, it being held that it will cause less confusion in nomenclature and bibliography to retain as distinct two forms which must eventually be united, than it will to unite under one name two forms which must in the end be separated.

The whole number of genera which, in the acceptation of the writer, are found in the region indicated is 1118; the whole number of species 3234. These are distributed among the large groups, as shown in table following. It is proper to note that in this list there is included a relatively small number of existing species whose remains have been found in pleistocene deposits of old lakes and of caves, accompanied by remains of other species either now extinct or having a geographical distribution different from the present. A larger proportional number of such living species is found in the group of birds than in any other, there being 33 such species.

GENERA AND SPECIES OF NORTH AMERICAN FOSSIL VERTEBRATA IN THE GROUPS NAMED.

FISHES.

Group.	Genera.	Species.
Elasmobranchii	114	537
Ichthyodorulites*	34	136
Aspidoganoidei†	3	7
Placodermi	18	43
Dipnoi	10	43
Crossopterygia	16	41
Actinopteri	102	303
Total of fishes	297	1110

BATRACHIANS.

Group.	Genera.	Species.
Stegocephali	41	88
Urodela	2	5
Anura	1	1
Total of batrachians	44	94

REPTILES.

Group.	Genera.	Species.
Cotylosauria	12	24
Chelydosauria	2	3
Anomodontia	1	1
Pelycosauria	12	29
Testudines	37	148
Ichthyosauria	5	7
Plesiosauria	14	27
Rhynchocephalia	3	9
Pterosauria	3	8
Loricata‡	17	62
Squamata⁂	48	126
Dinosauria	65	154
Total of reptiles	219	598

BIRDS.

Genera, 59; species, 102.

MAMMALS.

Group.	Genera.	Species.
Protodonta	2	2
Allotheria	13	41
Didelphia	21	44
Bruta	16	36
Sirenia	5	7
Cete	42	77
Condylarthra	9	26
Perissodactyla	43	215
Artiodactyla	75	207
Ancylopoda	3	5
Amblypoda	13	40
Dinocerea	5	33
Proboscidea	2	18
Tillodontia	3	13
Glires	40	99
Insectivora	18	22
Chiroptera	5	7
Creodonta	39	103
Carnivora	55	134
Primates	27	53
Total of mammals	436	1182

Foot-prints: Genera, 63; species, 147.
Total of all groups: Genera, 1118; species, 3234.

*Mostly, at least, defensive spines of elasmobranchs.

† This name, proposed by Dr. Gill, in 1876, antedates Cope's *Ostracodermi* and *Ostracophori*.

‡ Crocodiles and their allies.

⁂ Mosasaurs, lizards and snakes.

Of the classes of the list presented above, the birds are conspicuous because of the small number of species represented, the 102 contrasting strongly with the approximately 1100 species now inhabiting North America. It seems not unlikely that the habit possessed by birds of living in the open air and the tendency of their bodies to float for a long time after death have insured their destruction. Doubtless many of the smaller reptiles and mammals have been preserved because they met death in their burrows. A floating bird would be devoured by large fishes and reptiles.

The list of the reptiles is a large one, the two largest orders being those of the turtles and the dinosaurs. The latter owe their preservation mainly to their great size. The turtles are likely to become buried in deposits, because they are mostly inhabitants of the water, they readily sink when dead, and they are not easily devoured.

The mammals present a formidable array. One-half of the groups in the list are extinct, either wholly or from this continent. Those which have here living representatives show many more fossil than living species, excepting the bats, the rodents and the insectivores. The last two groups, being composed mostly of small species, have

probably not yet received their share of the attention of collectors. Of rodents there are now living in North America over 300 species, of bats about 40 species, and of insectivores about 40 species.

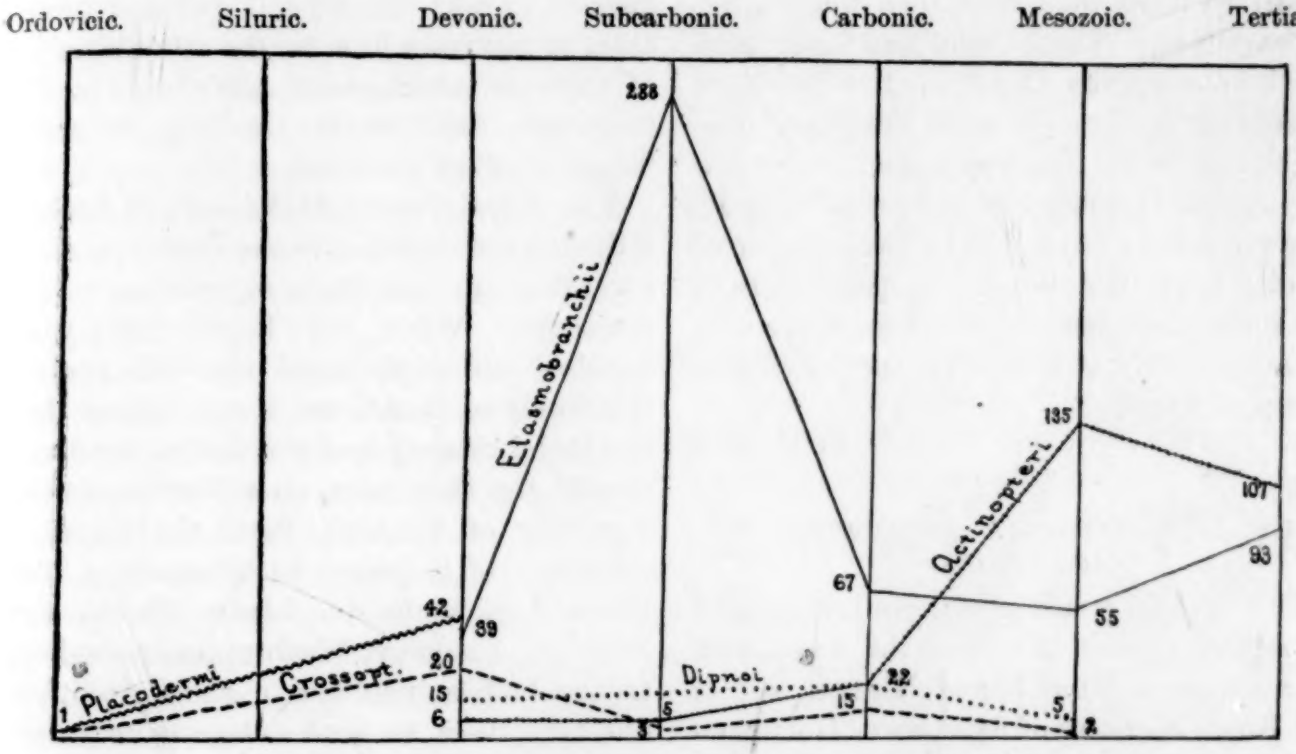

Diagram showing the distribution of North American fossil fishes.

The animals which are included under the general name of fishes furnish such interesting results that an attempt is made to furnish a graphic illustration of the time distribution of the principal groups. In examining this we are at once struck with the enormous development of the elasmobranchs during the Subcarbonic period. Furthermore, from the elasmobranchs presented in the illustration have been excluded the ichthyodorulites, the great majority of which are undoubtedly the defensive spines of shark-like animals. The distribution of the species of these is as follows: Siluric, 2; Devonic, 27; Subcarbonic, 83; Carbonic, including the Permic, 22. Had these been included, the Subcarbonic peak would have been uplifted by an amount equal to two-thirds its present height, while the elevations of the Devonic and Carbonic would not have been greatly increased. The occurrence of so many defensive spines in the Subcarbonic, when such a variety of elasmobranchs is indicated by teeth, is a pretty plain suggestion that in very many cases a genus founded on a spine is identical with some other genus based on teeth; for it is not probable that many of the ichthyodorulite-bearing fishes were toothless. After the Subcarbonic period the elasmobranch line descends rapidly in the Carbonic, slowly in the Mesozoic, and rises slightly in the Tertiary. At the present day there are recognized only about 86 species of elasmobranchs living along the whole American coast, north of Mexico.

Although the ichthyodorulites have been excluded from the elasmobranch species in the illustration, the line has been extended to the Siluric, because of the occurrence of *Onchus* in it.

In like manner the line representing the Placodermi and the Crossopterygia have

been prolonged backward to the Ordovicic, in consideration of Mr. C. D. Walcott's genera *Astraspis* and *Eriptychius*.

In contrast with the elasmobranchs the actinopterous fishes, which entered on their career as 'a feeble folk' in the Devonic, seem hardly to have held their own during the Subcarbonic. Their numbers increased slowly during the Carbonic, the feri then expanded rapidly during the Mesozoic. The slight fall in the number of known species during the Tertiary does not probably indicate an actual reduction in the number of species that then lived. In the waters of the region here contemplated there are now living probably at least 1500 species of this group of fishes.

O. P. Hay.

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*THE INTERNATIONAL ASSOCIATION OF ACADEMIES.**

For several years past there has existed an Association or Cartell of the Academies of Sciences of Munich and Vienna, and of the Royal Societies of Sciences of Göttingen and Leipzig, which has met yearly to discuss matters of common interest, and the combined action of these bodies has in several ways been fruitful of results. Representatives of the Royal Society of London attended the meeting held last year at Göttingen, as well as that which took place the previous year at Leipzig, chiefly with the object of discussing the project of an international catalogue of scientific literature which the Society has been engaged in promoting.

When the invitation was conveyed to the Royal Society of London to send representatives to the Göttingen meeting, it was intimated that the Cartell would be glad to learn the views of the Society as to the possibility of its joining the Association. The delegates appointed from London were instructed to state that the Royal Society would be disposed to join, provided that the organization were so extended as to assume a truly international character. This suggestion was not only accepted in principle at Göttingen, but it was agreed that the Royal Society of London should be requested to take the steps, if thought desirable, to ascertain how far the establishment of such an international association would commend itself to the leading scientific bodies of other countries.

The Royal Society of Sciences of Berlin, although not included in the Cartell, has for several years past been represented at its meetings. When the Royal Society of London had ascertained that the project was likely to find favor, it was agreed that the Royal Society and the Berlin Academy should together issue an invitation to the Academy of Sciences, Paris, the Imperial Academy of Sciences, St. Petersburg, the Reale Accademia dei Lincei, Rome, the National Academy, Washington, as well as to the bodies included in the Cartell, requesting them to send delegates to a conference to be held in Wiesbaden on the 10th and 11th of October.

At the conference, excepting the Reale Accademia dei Lincei, which was unable to send delegates, although in full sympathy with the movement, all the bodies invited were represented—the Berlin Academy by Messrs. Auwers, Virchow, and Diels; the Göttingen Society by Messrs. Ehlers and Leo; the Leipzig Society by Messrs. Windisch and Wislicenus; the Royal Society by Messrs. Rücker, Armstrong, and Schuster; the Munich Academy by Messrs. von Zittel, Dyck and von Sicherer; the Paris Academy by Messrs. Darboux and Moissan; the St. Petersburg Academy by Messrs. Famintzine and Salemann; the Washington Academy by Messrs. Newcomb, Remsen, and Bowditch; and the Vienna Academy by Messrs. Mussafia, von Lang, Lieben, and Gomperz.

* From the London *Times*.

Professor Auwers one of the secretaries of the Berlin Academy, occupied the chair, and the success of the meeting was largely due to the extreme ability and tact, combined with judicious firmness, with which he conducted the proceedings. Besides showing himself a master of the three languages—German, French and English—used in the debates, he was thoroughly informed on every point which came up for discussion. Fortunately, all the delegates appeared to be actuated by the desire to coöperate, and there was little difficulty in framing statutes which all were prepared to accept.

The immediate outcome of the conference has been that it is resolved to found an international union of the principal scientific and literary bodies of the world, the object of which will be to initiate or promote scientific enterprises of general interest recommended by one or more of the associated bodies, and to facilitate scientific intercourse between different countries. It is to be known as the International Association of Academies. A number of important bodies besides those represented at Wiesbaden are to be invited to join. General meetings of delegates from the various constituent academies are to take place, as a rule, at intervals of three years, but the interval may be varied and special meetings held, if necessary. The Royal Society had proposed, prior to the conference, that the first general meeting should be held in Paris next year. At the general meetings two sections will be constituted, one dealing with mathematics and the natural sciences, the other with arts and philosophy.

A council is to be appointed which will carry on the business in the intervals between meetings. The formation of committees of experts to initiate and promote scientific investigations of international importance is also contemplated.

It remains to be mentioned that the Berlin Academy had also arranged for the entertainment of the delegates at the close of the debates. On the Monday evening they were invited to attend a performance of Lortzing's opera *Undine*, and on the Tuesday they were entertained at dinner in the Kurhaus. On the latter occasion Professor Virchow occupied the chair, and opened the proceedings by toasting the delegates generally; he was followed by Professor Darboux, of Paris, who proposed the health of the Berlin Academy, and in the course of the evening numerous other toasts were proposed by the delegates.

SCIENTIFIC BOOKS.

The Kinetic Theory of Gases. By S. H. BURBURY. Cambridge University Press. 1899. Pp. 157.

Mr. Burbury has long been known as an occasional contributor to the Kinetic Theory of Gases. The first edition of Watson's treatise on this subject, published in 1876, acknowledged the indebtedness of its author to him; and in that very interesting discussion of the Kinetic Theory which was begun at the Oxford meeting of the British Association in 1894 and continued for months afterwards in *Nature*, Mr. Burbury took a conspicuous part, appearing as the expounder and defender of Boltzmann's *H*-theorem in answer to the question which so many have asked in secret, and which Mr. Culverwell asked in print, '*What is the H-theorem and what does it prove*'? Thanks to this discussion, to the more recent publication of Boltzmann's *Vorlesungen über Gas-theorie*, and finally to this treatise by Burbury, this question is not so difficult to answer as it was a few years ago; but it is probable that some readers of SCIENCE, even to this day, know less about the *H*-theorem than is contained in the following sketch of its history, which will serve to bring out one of the most interesting features of the book before us:

In 1860 Maxwell deduced from the laws of probability an expression for the final distribution of components of velocity among the particles of a gas consisting of very small elastic spheres having no action upon each other ex-

cept at the instants of collision. Many ingenious minds have since occupied themselves with this problem; and many discussions of it have been published with the purpose of improving upon the work of Maxwell, though none, so far as the reviewer is aware, has reached, for the case of a much rarefied gas, a different result. The especial defect of Maxwell's argument is his failure to show that the condition which he arrives at as the final condition of the gas is a necessary state, although he has shown it to be a possible state. Boltzmann especially has undertaken to supply what was lacking in the demonstration of Maxwell. Starting with a gas which has not yet reached its condition of 'stationary motion,' and in which the particles influence each other only at impact, he made a very particular study of the possibilities and results of collisions, with the purpose of showing that these results would as a whole tend to bring about the state of Maxwellian distribution of velocities, which would therefore be a necessary and final state. As an indispensable part of his argument he framed and used the so-called *H-theorem*. To attempt here a definite statement of this theorem would be folly. Let it suffice that H is a function based upon the laws of probability and that, according to Boltzmann, it necessarily decreases, through collisions, with lapse of time and by its diminution marks the progress of the gas towards the Maxwellian state, which is attained when H becomes a minimum. But critics have objected, Why must the H function diminish? If we imagine the velocity of every particle of the gas reversed at any instant, the H function ought to increase. Are not the reverse velocities as probable as those you imagine? And should not the net effect of all collisions be to leave H unchanged? To this Boltzmann replied that reverse velocities would indeed cause H to increase; but he urged that it was not allowable to imagine every velocity reversed. For example, in a case where a partial mixture of gases has come about by interdiffusion, a reversal of all velocities would cause the gases to separate from each other. This was an admirable and enlightening reply to the doubt raised, but the discussion is so beset with difficulties and possible obscurities that Mr. Burbury has done students good service in examining with much care a fundamental assumption upon which the argument of Boltzmann is based. Burbury's statement of this 'assumption A' is as follows:

"The chance of any molecule having velocity in x between u and $u + du$ is independent, not only of its position in space, but also of the v, w, which it has in directions y and z, and further except in the case mentioned below, it is independent of the positions and velocities at the instant of all the other molecules of the system. The excepted case is when the two molecules are so placed that they are, or very recently have been, within one another's sphere of action. The force of this exception, and the necessity for it, will appear in the consideration of the H-theorem."

Some of the most salient facts of the situation are these:

1. Boltzmann in preparing his H-theorem treats the number of pairs of particles which are *on the point of colliding*, at given velocities and angles, as a function of these velocities and angles and of these alone; but he treats the number of pairs which are *just parting from each other* at the same velocities and angles as a function of the pre-collision velocities and angles of the now separating pairs, on the ground that their number is determined by the number of pairs which an instant before were on the point of colliding with each other at certain velocities and angles alone capable of producing the post-collision velocities and angles mentioned. This is a matter of principle, not merely of convenience; for if particles just about to collide and particles just parting were numbered by like functions of velocities and angles, the number of particles leaving any class would be exactly equal to the number entering it, and there would be no H-theorem.

2. The function which expresses the number of particles having velocities lying within certain limits becomes the Maxwellian function when H has reached a minimum; and when this state is attained the exception noted in assumption A disappears.

The close scrutiny of assumptions is characteristic of Burbury's book. The fact that he has

named the statement above *assumption A* shows that he has in mind an assumption *B*. This latter, however, he does not attribute to Boltzmann. It is his own, and is of a character to show that he is entirely undismayed by the difficulties of the Kinetic Theory in its ordinary form. Assumption *B* is proposed as a substitute for assumption *A*, and it runs as follows:

"The chance of a given molecule having at any instant assigned velocities is *not* independent of the positions and velocities of all the other molecules at the instant. On this assumption *B*, instead of deducing the chance of the members of a group of n molecules having respectively at any instant the velocities $u_1 \cdots u_1 + du_1$, etc., from the assumed chances for individual molecules, we must reverse the process." According to this assumption "the chance that the x velocity of the first molecule shall lie between u_1 and $u_1 + du_1$, whatever be the positions and velocities of the other $n-1$ molecules, is

$$\int\int\int_{-\infty}^{+\infty} (dx_1 dx_2 \cdots dz_n\, dv_1 dw_1 du_2 \cdots dw_n) \times F(x_1 y_1 \cdots u_1 \cdots w_n).''$$

He does not introduce this complication out of pure wantonness, nor is he in this particular case making an effort to get, in his own phrase, 'as near an approach to chaos as is possible in an imperfect world.' It is his hope by means of assumption *B* so to generalize the Kinetic Theory as to make it fit the case of a vapor approaching liquefaction. A few quotations will indicate some of the aims and results of his discussion. Thus on p. 46 under the heading *Finite Forces*, by which phrase he means to exclude the case of 'rigid elastic bodies,' which exert infinite force upon each other at collision, he writes, "I propose to prove in this and the next chapter that in a system consisting of molecules of finite dimensions in stationary motion, it is not true for molecules very near to one another, that the chances of their having velocities between assigned limits are independent, as condition *A* assumes; but, on the contrary, if the forces be repulsive, they tend to move on the average in the same direction," etc.

In § 99, under the heading 'Concerning the Maxwell-Boltzmann Law $m_1\bar{a}_1^2 = m_2\bar{a}_2^2 =$ etc.,' that is, the law which asserts that the mean kinetic energy of the molecules of one species of particles is equal to that of the molecules of any other species at the same temperature, we have, "It seems therefore to follow that the law $m_1\bar{a}_1^2 = m_2\bar{a}_2^2$, etc., cannot hold universally. It can be accepted only on the authority of the great physicists by whose name it is known."

In § 107, "It follows from this result that" * * * "the system would tend more and more, with increasing number of molecules in a given space, to assume the form of a number of denser aggregates, say clouds, moving through a comparatively rare medium." On p. 112, after a passage similar to that just quoted, but containing other particulars, we have "Such is the process which our analysis leads us to expect. Physicists may consider how far it corresponds with what is known to take place in gases under condensation, or on what (if any) farther hypothesis it may be made to correspond with it." This last quotation is especially significant as to the point of view from which the whole book is written.

The last chapter (X.) is devoted to *Thermodynamical Relations*. It contains, with considerable matter descriptive of the speculations of others, the author's kinetic 'proof of the second law' of thermodynamics in accordance with 'assumption *B*.' His proof with assumption *A* was published in 1876, and Mr. G. H. Bryan,* who has made an exhaustive study of such efforts, declares it to be the simplest proof based on the 'Boltzmann-Maxwell law of distribution of speed.' But the wayfaring physicist who is seeking an excuse for avoiding an encounter with the new and more general proof offered by Mr. Burbury will find it in another remark made by Mr. Bryan in the conclusion of his report.† "Although many of the researches mentioned in this report are not infrequently called dynamical proofs of the Second Law, yet to prove the Second Law, about which we know something, by means of molecules, about which we know much less, would not be in consonance with the sentiments [judge the unknown from the known] expressed at the end of the last paragraph. The most conclusive evidence for regarding Carnot's principle

* B. A. Report, 1891, p. 85.

† Idem, p. 121.

as a theorem in molecular dynamics lies in the remarkable agreement between the results obtained by the methods described in the three different sections of this report, all of which are based on different fundamental hypotheses.''

EDWIN H. HALL.

CAMBRIDGE, October 28, 1899.

Elementi di calcolo infinitesimale con numerose applicazione geometriche. Per ERNESTO CESÀRO, professore ordinario della R. Universita di Napoli. Naples, Lorenzo Alvano. 1899. 8vo. Pp. 400.

The absence of a text-book on the calculus from a too well-known series of American mathematical text-books was recently remarked. The omission was excused by the observation that the author of the series knew nothing about the calculus. It might have been well for the cause of secondary and superior mathematical education in this country had the same modest confession been called into execution earlier and prevented the construction of the patch-work, fragmentary, stereotyped algebra of the same series. Contrast the confession of the razor-maker with the refusal made lately by a mathematician who declined to prepare an elementary treatise on the infinitesimal calculus on the ground that he knew too little arithmetic and algebra.

Cesàro had the courage to learn and make his mathematics before he began to publish any of his courses. His treatise* on algebraical analysis appeared five years ago and was most favorably received, although published against the advice of his friends. This work naturally contained an introduction to the infinitesimal calculus which gave full promise of the superb treatise which comes from the press this year. The former, which is by no means so finished a work of art as the latter, is a collection of sixty lectures on substitutions and determinants, linear forms, quadratic forms, irrational numbers, limits, series, functions, developments in series, complex numbers, quaternions, elimination, symmetric functions, enumeration of roots, numeric and algebraic resolution of equations, differences and interpolation, and factorial developments.

*Cesàro, Corso di Analisi algebrica con introduzione al Calcolo infinitesimale, Turin, Bocca, 1894.

Cesàro's course in the calculus is designed after the following plan the style of whose exposition is a most fortunate combination of mathematical rigor and poetic expression. There are three grand divisions occupied in order with fundamental theories, the differential calculus, and the integral calculus. The first of these consists of four chapters devoted to functions, derivatives, developments in series, and functions of several variables; the second part also contains four chapters presenting the theory of differentiation and its applications to the theories of plane curves, space curves and surfaces; the last division comprises five chapters on integration, applications to the evaluation of certain remarkable classes of integrals, applications to geometrical mensuration, differential equations and variations.

The reviewer has space to analyze but few of the chapters of this valuable work. The first chapter exhibits the principal properties of functions in all their modern refinement by the evolution of the following theorems: 1° If a function is finite throughout an interval it always admits of an inferior limit and a superior limit; 2° If a function is finite for all the numbers of an interval it is finite throughout the interval; 3° The first theorem of Weierstrass, if a function is finite in a finite interval, the latter contains at least one number for which the function has the same limits, inferior and superior, as the interval itself; 4° For the existence of a finite limit of $f(x)$ to the right of a it is sufficient that, given ε positive and as small as we wish, there can always be found a positive number h, such that, for every pair of values x' and x'' taken within the interval $(a, a + h)$, excluding the inferior limit, the absolute value of $f(x') - f(x'')$ is less than ε; 5° If $f(x)$ is continuous and different from zero for $x = a$, it possesses at a the sign of $f(a)$; 6° If a function is continuous in an interval it is also finite in the interval; 7° A function continuous in an interval at the extremities of which it takes opposite signs must vanish at least once in the interval; 8° A continuous function cannot pass from one value to another without passing through all the intermediate values; 9° Second theorem of Weierstrass, every function continuous in a finite interval takes the maximum and minimum value

in the same interval ; 10° Cantor's theorem, if a function is continuous in a finite interval, we can determine for every positive number ε as small as we wish, a number h, such that in any interval of magnitude h contained within the given interval, the oscillation of the function shall be less than ε.

The second chapter deduces by the method of limits the rules of derivation of standard functions, together with the properties of derived functions, and concludes with the complements of the theory of limits introduced in the first chapter. The third chapter devoted to series discusses in order the convergence criteria, the Taylor-Maclaurin formula, the asymptotic evaluation of power-series, the technical discussion of functions, the interpolation formula and the decomposition of rational functions into sums of simple fractions. The notions of the first chapter are extended to functions of more than one variable in the fourth chapter, with special reference to the problems of maxima and minima. The examples and exercises of these chapters, most of which are resolved in full, are especially valuable ; the collection of classic ones of derivativeless functions calls for remark ; the character of these exercises is well exemplified by the following which are given in illustration of the theory of maxima and minima : 1° Calculate the lengths of the axes of the general conic ; 2° Determine the lengths of the axes of the section of an ellipsoid made by a given diametral plane ; 3° Find the minimum distance between two right lines ; 4° Seek the minimum value of the sum of the squares of n variables connected by $m < n$ linear equations ; 5° The method of least squares.

In this day of multiple algebras and multiple geometries it is not surprising to find Cesàro proposing multiplications of the differential calculus. These observations form an interesting section of the fifth chapter which gives the ordinary methods for the differentiation of explicit and implicit functions of one or several variables. The differential dx of the independant variable, arbitrary for each value of x, Cesàro considers as the product of an infinitesimal a independent of x by an arbitrary function of x, *i. e.*, $dx = a\chi(x)$. Differentiating this expression we have

$$d^2x = da\chi = ad\chi = a\chi' dx = a^2\chi\chi',$$
$$d^3x = a^3(\chi\chi'^2 + \chi^2\chi''),$$
$$d^4x = a^4(\chi\chi'^3 + 4\chi^2\chi'\chi'' + \chi^3\chi'''), \cdots$$

The results of these successive differentiations become rapidly more complicated, and would as rapidly rob the calculus of most of its advantages if the function χ be allowed to retain its arbitrary character. For convenience $\chi(x)$ is made equal unity and we have $d^2x = d^3x = \cdots = 0$, which expresses that x is equicrescent, *i. e.*, that the differential of the independent variable is independent of the variable. However it is only necessary to call in the fundamental principle of the integral calculus to show that every form of calculus resulting from a change of form in the function χ reduces to the ordinary calculus ; the reduction is effected in precisely the same manner that a change of independent variable is made. Thus, there is always a function t of x whose derivative is $1 : \chi(x)$, then

$$dt = t'dx = \frac{1}{\chi(x)} \cdot a\chi(x) = a, \quad d^2t = d^3t = \cdots = 0.$$

The possibility of a calculus in which no variable possesses a constant differential is not excluded, but it is certain that the simplicity and homogeneity of its formulæ and the precision with which the ordinary calculus assigns the orders of its infinitesimals will not be among the advantages of the new calculus.

It may be remarked here in passing that a Norwegian mathematician attempted a few years ago to found a new calculus, in which the fundamental rôle taken by addition and subtraction in the ordinary calculus was assigned to the operations of multiplication and division. The resulting forms yielded certain continued products, but were otherwise fruitless.

The sixth and seventh chapters contain the geometrical applications to plane and space curves. These chapters must have offered a sore temptatation to the author to make exclusive use of his own elegant method of intrinsic analysis, but the reader finds no method employed to the exclusion of all others. The applications follow the usual order of tangents, normals, curvature, asymptotes, singularities, contacts, and envelopes. The examples are happily chosen, and the chapters amply illustrated with well executed figures.

The elements of the theory of surfaces are introduced in the eighth chapter and applied to ruled surfaces and envelopes. The theory of curvature is elaborated in detail, including the notions of mean curvature due to Germain, total curvature conceived by Gauss, and quadratic curvature of Casorati. The chapter concludes with the determination and properties of the remarkable lines of a surface.

The ninth chapter begins the study of the inverse problems by presenting the fundamental concepts and rules of simple and multiple integration. The tenth chapter evaluates the well-known forms of rational, irrational and transcendental indefinite integrals, and terminates with certain classes of definite integrals, including elliptic and eulerian integrals; the nature of the xample is indicated by the following, which occurs in the study of vortices:

$$\frac{ab}{2\pi}\int^{2\pi}\frac{\cos\theta d\theta}{\sqrt{a^2+b^2+c^2-2ab\cos\theta}}.$$

After making the ordinary applications to mensuration in the eleventh chapter, the author undertakes the elements of the theory of differential equations in the twelfth chapter. The distinctions between the notions general, particular, and singular integral are clearly made. The cases of integrable ordinary differential equations are classified as follows: 1° variables separable; 2° functions homogeneous; 3° one variable absent; 4° second order equation lacking one variable always reducible to one of first order; 5° linear equation; 6° Bernouilli's equation; 7° Clairaut's equation; 8° the form $y = x\phi(y') + \psi(y')$, when not a Clairaut equation is reducible to a linear equation; 9° Riccati's equation and its characteristic property that the anharmonic ratio of any four particular integrals is constant. No reference is made to Lie's theories. A well selected list of resolved problems is followed by geometrical applications of differential equations to plane curves, trajectories and surfaces. The general linear equation and equations with constant coefficients are studied somewhat *in extenso*. Passing then to equations in more than two variables, the author takes up total differential equations and simultaneous ordinary equations and terminates the chapter with a short treatment of the partial differential equation.

The last chapter of the book gives the elementary notions of the calculus of variations in six pages. The volume concludes with notes on the concept of limit, oscillatory extremes, demonstration of Cantor's theorem, Hadamard's theorem, minima and maxima of functions, cusps and flexions at a pole, torsion of curves, calculation of the curvature of a surface, formulæ of Rodrigues, general formula of Stirling.

E. O. Lovett.

Princeton, New Jersey.

Pflanzen- und Tierverbreitung, in Hann, Hochstetter und Pokomy, Algemeine Erdkunde. By A. Kirchhoff. Verlag, F. Tempsky, Wien. Aufl. 5. 1899.

This volume, by Alfred Kirchhoff, forms the third part of the new edition of a well-known and compendious manual of pure as distinguished from economic geography. It maintains the high standard of the preceding parts by Hann and by Brückner, and is a welcome addition to the literature of geo-biology. Of the 157 figures, a large proportion are not easily accessible elsewhere or are quite new. The maps, while not emphasizing the developmental phases of faunal and floral distribution as do, for example, those of Engler, are, nevertheless, more nearly in accord with modern ideas than those of Grisebach or Decandolle. The ecological factors are, by no means, neglected, as they were so generally in the older books. While it is true that they are scarcely so exhaustively discussed and laboriously analyzed as in the special treatises of Warming and Schimper, yet they are clearly, ably and adequately presented. Kirchhoff's work, has a certain advantage over the special *Tierlebens* and *Pflanzen-geographies* in its broad outlook upon both the fields of biological science. It falls naturally enough into three divisions, the first including the general discussion of the relations between the earth and the organisms that inhabit it, the second comprising the analysis of floral, and the third that of faunal regions. The peculiar excellence of the treatment is apparent at once in the opening chapters on the migrations of organisms, on the environmental conditions

of plants and animals, on the modifications and hereditary distribution, and particularly, perhaps, in the very admirable fifth chapter of the first part which, under the title of 'elements of plant and animal distribution' gives precisely the catholic and panoramic view of geographical distribution that must be regarded as most desirable. Here are included with much wealth of illustration and judgment as to detail, accounts of the distribution of species, both plant and animal, of genera and of families and orders. Statistics of distribution, physiognomic and climatic groups, plant and animal zones, domesticated plants and animals and colonial aggregates are skilfully compiled and made the basis for useful generalization.

The second chapter, that dealing with floral regions, reminds one upon the whole of the Grisebachian discussion, though somewhat tempered by recent research. It is scarcely abreast, however, of the work of Drude and a list of the *Florenreichen* will show that the tone, on the whole, is analytic rather than synthetic. They are as follows: Northern, Mediterranean, Turanian, East Asian, Indian, tropical African, South African, tropical American, extra tropical South American, Australian, New Zealandian, Polynesian, Oceanic, making in all thirteen principal floral divisions of the earth. The omission of an Antarctic region seems scarcely to be justified. The principal regions of faunal distributions are slightly different and are added here for comparison. They are: North-polar, Northern, Eurasian, Mediterranean, Turanian, Indian, Trans-Saharan, Madagascaran, North American, tropical American, Andian-Argentine, West Indian, Australian, Papuan, New Zealandian, Polynesian and Oceanic, making in all seventeen principal faunal regions. That the divisions for plants and animals correspond so generally is impressively indicated by these classifications. Minor differences, however, exist and indicate the rather stronger climatic influence upon the stationary plants and the relatively stronger influence of insular isolation upon the locomotive animals. Thus Papuan, West Indian and Madagascaran divisions are necessary in the classification of animal groups, but not in that of plant societies. Again, North America, exclusive of the polar regions, becomes a single province for animals, while for plants it is divided into two upon a basis of climate.

A quite insufficient index closes the volume, and it is to be regretted that its stores of useful and sometimes elaborate information are not made more easily accessible.

CONWAY MACMILLAN.

Sewage-Analysis. By J. ALFRED WANKLYN and WILLIAM JOHN COOPER. A practical treatise on the examination of sewage and affluents from sewage. Including also a chapter on Utilization and Purification of Sewage. Philadelphia, J. B. Lippincott Company. 1899. Pp. xvi + 220.

The first eighty-two pages are devoted to analytical processes not essentially different from those published in 'Wanklyn's Water Analysis,' and in view of the fact that polluted water and sewage differ but in degree of pollution, it is reasonable to doubt the necessity of repeating information such as this to those already familiar with water methods.

One must always open with respect a book bearing the name of 'Wanklyn,' but in these days of active and accurate water investigation it would seem that the author of the 'Albuminoid Ammonia Process' has hardly kept in touch with what advances have been made by those who would be glad to be accounted his pupils. Thus the old writing paper packing for the retort neck is yet retained in the treatise under consideration; and a confidence is reposed in the 'goodness' of 'good tap-water' for final rinsing, which many water-analysts know to be misplaced. Much space has been given to criticisms of methods of which the authors do not approve, and the style of such criticism suggests the old acrimonious discussion of some years ago.

It is most unfortunate that the authors should have seen fit to refer to the oxidation of organic compounds through the action of germ life as 'a fashionable fad and delusion of the day'; nor is it seemly to announce that "neither is the burning of the kitchen-fire nor the action of the steam-engine a manifestation of bacterial action."

Such remarks strike the reader as unworthy

of men of repute. Under the section dealing with sewage purification, there is no mention whatever of the work done by the Massachusetts Board of Health.

The appendix is voluminous and consists largely of extracts from previous papers published by the authors during the years 1866 to 1891. W. P. Mason.

Laboratory Manual, Experiments to Illustrate the Elementary Principles of Chemistry. By H. W. Hillyer, Ph.D., Assistant Professor of Organic Chemistry in the University of Wisconsin. New York, The Macmillan Company. 1899. Pp. vi+200. Price, 90 cents.

After a short chapter on manipulation, this manual is divided into two parts. Part I. is given to the preparation and properties of the elements and their compounds. The usual illustrative experiments are given, all of these being of a purely qualitative character. A few problems for calculation are, however, inserted. Part II. is devoted to the verification of quantitative laws, especially the laws of constant and multiple proportion, the laws of combination for gases, and vapor densities. Very much, of course, depends on the teacher, but there seems to be some danger that the work of many students with the first part of this book will degenerate into merely playing with chemicals. The old method of preparing stannic chloride given on page 144 might, with advantage, be replaced by that of Lorenz, (Zeit. f. Anorg. Ch. 10, 44.).

Inorganic Chemical Preparations. By Felix Lengfeld, Assistant Professor of Inorganic Chemistry in the University of Chicago. New York, The Macmillan Company. 1899. Pp. xviii+57. Price, 60 cents.

The study of inorganic chemical preparations deserves a much larger place than has usually been assigned to the subject in chemical courses. The selection of topics in Dr. Lengfeld's book is excellent. Some of the directions are, perhaps, a little too concise for the use of students who have not had a good deal of laboratory experience. Without close watching many students would certainly fall into serious mistakes—but, then, a student often learns more from a mistake than by doing a thing right the first time.

W. A. Noyes.

SCIENTIFIC JOURNALS AND ARTICLES.

The *American Journal of Science* for November contains the following articles:

'Types of March Weather in the United States,' by O. L. Fassig.

'Some new Minerals from the Zinc Mines at Franklin, N. J., and Note concerning the Chemical Composition of Ganomalite,' by S. L. Penfield and C. H. Warren.

'Action of Acetylene on the Oxides of Copper,' by F. A. Gooch and DeF. Baldwin.

'Andesites of the Aroostock Volcanic Area of Maine,' by H. E. Gregory.

'New mode of occurrence of Ruby in North Carolina,' by J. W. Judd and W. E. Hidden. With Crystallographic Notes by J. H. Pratt.

The Osprey for October, makes its appearance under new editors and is a particularly good number, being very strong in interesting notes. The first article, 'The Home of a Pair of Wood Thrushes' is by R. W. Johnson; then follow 'The Butcher Bird in Florida,' by Mrs. M. A. Ohlinger; 'Peculiar Nesting of the Hooded Merganser,' by Glen Rinker; 'Robin Recitals and Variations,' by P. M. Silloway, and 'Nesting of the Bald Eagle,' by Wm. H. Fisher. The principal article, 'Wild Guinea-Fowl of Barbuda,' by Frederick A. Ober, is in that writer's best vein. L. A. Fuertes notes the occurrence of 'Two Rare Warblers at Ithaca.' In the correspondence Mr. J. Parker Norris replies to his critics in a letter on 'The Utility of Large Series of Eggs.'

Appleton's Popular Science Monthly, for November, contains a portrait and sketch of Dr. George M. Sternberg, Surgeon-General, U. S. A. The number also contains an article on Cambridge University by Mr. Herbert Stotesbury with portraits of Sir Michael Foster, Professors J. J. Thomson, G. H. Darwin, Henry Sidgwick and James Ward, Dr. Donald Macalister and Sir George Stokes. Other articles are on 'Wireless Telegraphy,' by Professor John Trowbridge; 'Emigrant Diamonds in America,' by Dr. Wm. H. Hobbs; 'On Spider Bites' and 'Kissing Bugs,' by Dr. L. O. Howard, and a review of Wallace's 'Wonderful Century,' by Professor W. K. Brooks.

SOCIETIES AND ACADEMIES.

AMERICAN MATHEMATICAL SOCIETY.

A REGULAR meeting of the American Mathematical Society was held at Columbia University, New York City, on Saturday, October 28th. Thirty-one persons attended the two sessions, and twelve papers were presented. Immediately at the opening of the morning session a recess was taken to enable the members to hear the Presidential Address of Professor Rowland before the American Physical Society, which met in the same building. The simultaneous meeting of the two societies naturally resulted in a reinforcement of interest and activity, and it is hoped that this and other coöperative action may become the established order.

It has been arranged with a view to economy of time that hereafter the morning session of the meetings of the Society shall open at 11 o'clock, and the afternoon session at 2 o'clock. The Council will meet at 10:15 A. M.

The Editorial Board announced that the arrangements for publishing the *Transactions*, the newly created organ of the Society, were in a most favorable state of progress. The first number will appear January 1, 1900. The fact that two first-class journals are not only possible but actually required for the publication of the mathematical output of this country is a striking evidence of the growth of the science here in the last few years.

The following persons were elected to membership in the Society:

Professor M. E. Bogarte, Northern Indiana Normal School, Valparaiso, Ind.; Mr. A. S. Gale, Yale University; Mr. B. L. Groat, University of Minnesota; Dr. Edward Kasner, Columbia University; Professor J. A. Miller, University of Indiana; Professor A. M. Sawin, Clark University, Atlanta, Ga.; Professor S. A. Singer, Capital University, Columbus, Ohio; Dr. H. E. Slaught, University of Chicago; Professor E. P. Thompson, Miami University, Oxford, Ohio. Seven applications for membership were received.

The following papers were read:

(1) Professor PAUL GORDAN: 'Formentheoretische Entwickelung der in Herrn White's Abhandlung über Curven dritter Ordnung enthaltenen Sätze.'

(2) Professor E. O. LOVETT: 'The transformation of straight lines into spheres.'

(3) Dr. G. A. MILLER: 'On the simply transitive primitive groups.'

(4) Professor CHARLOTTE ANGAS SCOTT: 'The conditions imposed on a curve by assigned multiple points.'

(5) Professor E. H. MOORE: 'On the generational determination of abstract groups' (preliminary communication).

(6) Professor CHARLOTTE ANGAS SCOTT: 'The status of imaginaries in pure geometry.'

(7) Professor MAXIME BÔCHER: 'On Sturm's theorem of comparison' (preliminary communication).

(8) Professor F. MORLEY: 'On a fundamental geometric construction.'

(9) Mr. E. B. WILSON: 'The decomposition of the general collineation of space into three skew reflections.'

(10) Dr. G. A. MILLER: 'On the order of the product of two substitutions.'

(11) Mr. J. K. WHITTEMORE: 'On a generalization of the fundamental problem of the calculus of variation.'

(12) Mr. J. L. COOLIDGE: 'A projective representation of the imaginary points of a plane.'

The next meeting of the Society, which will be held on Thursday, December 28th, will be the annual meeting for the election of officers. The Chicago Section will meet at the University of Chicago on Thursday and Friday, December 28–9. At the annual meeting President Woodward will deliver a Presidential Address on 'The Century's Progress in Applied Mathematics.'

F. N. COLE,
Secretary.

TORREY BOTANICAL CLUB.

AT the meeting on October 10, 1899, nine new members were elected.

A series of nature-printed plant-plates was exhibited by Monsieur Alois Barta, temporarily at 521 East 82d Street, including algæ and phanerogams, all printed in natural colors. They excited great interest on account of their beauty and slight expense.

Dr. MacDougal referred to the success of the Sullivant Day at the Columbus meeting of the

American Association for the Advancement of Science this last August, one of the most interesting features of the meeting, and a tribute to the careful plans prepared for it by Mrs. E. G. Britton.

The remainder of the evening was devoted to reports from excursions and from summer observations by members.

Dr. Rusby, as guide to nine excursions in the spring, reported an average attendance of 31.

Menispermum rhizomes, as examined at Upper Mountain, N. J., April 8th, had begun no new growth and were still connected with the frost-killed stems, the point of change from rhizome to stem being purely an accidental result of exposure. The plant being essentially tropical, acts toward killing frost as if but imperfectly habituated to it.

Obolaria was well-developed this day, perhaps the earliest spring flower of its locality.

Professor Underwood reported on field work in July, and upon the Decoration Day excursion to Tullytown, Pa., about 20 persons from Philadelphia and 12 from New York present. *Isoetes riparis*, a tidal plant, occurred along tributary rivers.

Dr. Britton reported on the Fourth of July excursion to the Delaware River at Bull's Island, another *Isoetes*, *I. Dodgii*, occurring there.

Professor T. C. Porter reported the occurrence of *Equisetum littorale*, *Onosmodium Virgianum*, etc., at the Bull's Island locality.

Both of these excursions were contributory to Dr. Bretts' revision of Dr. Meyer's excellent catalogue of the Bucks county flora, soon to be issued. It is now being worked out with attention to details of distribution, ecology and modern taxonomic views. If we could have other counties here in the east worked up in a similar critical way, it would be a great aid to science.

Discussions regarding various Gentians followed.

Mr. Van Brunt reported seeing a single stem bearing 59 flowers of *Gentiana crinita*; all the upper, certainly 20, in full bloom. Putting the plants, after clipping, in the dark over night, and till 9 or 10 a. m., they expanded beautifully on exposure to the light.

Rev. L. T. Chamberlain reported 96 buds and blossoms on a single stem of *Gentiana crinita* in Massachusetts at West Brookfield. White blossoms came out in six weeks, the stem having bloomed in his study 42 days. Mr. Chamberlain also reported that Mr. Isaac Lea, of Philadelphia, had told him of finding a stem of *Gentiana crinita* with 150 blossoms.

Professor Porter called attention to white flowers of *G. Andrewsii;* it is this, he thinks, which was described as *G. alba.*

Mrs. Britton reported *G. quinqueflora* two or three feet high, and Professor Porter spoke of the habit of this plant to produce a great variety of size in the same soil, with little dwarfs with one flower at one inch high.

Professor Porter spoke of *G. flavida* as recently found in Bucks county.

Dr. Rusby referred to a successful experiment in scattering the seeds of the Fringed Gentians upon the snow, resulting in a profusion of young seedlings.

Mr. S. Henshaw paid a tribute to the beauty of the Alpine Gentians of the Old World.

Edward S. Burgess,
Secretary

Science Club of the University of Wisconsin.

The Science Club of the University of Wisconsin held its first meeting of the year on October 24th, with Mr. Charles R. Van Hise, the newly elected President, in the chair.

The programme of the evening consisted of the following papers:

'Earth Movements in the Pomperang Valley,' Connecticut, by Wm. H. Hobbs; 'Some Recent Observations Upon the Change of Length of Iron Due to Magnetization, by L. W. Austin.

The first paper was a study of block faulting in the Newark Formation of the Pomperang Valley, an area of fifty square miles in western Connecticut. It was illustrated by a large number of lantern slides.

Mr. Austin gave the results of his recent work on the change of length of iron in an alternating magnetic field. He finds that when iron is magnetized by means of an alternating current, the expansion is less than with a direct

current, and that this decrease becomes greater as the frequency becomes higher. There is a marked analogy between this phenomenon and the decrease in the magnetic permeability in an alternating magnetic field as the frequency is increased, a fact which has been recently established by Niethammer and M. Wien.

WM. H. HOBBS.

DISCUSSION AND CORRESPONDENCE.

GEOLOGICAL TIME.

EDITOR OF SCIENCE: Sir Archibald Geikie's recent forcible plea to working geologists for the more careful accumulation of data which may yield reliable estimates of geological time, makes the interesting suggestion given in SCIENCE, October 27th, by Professor Wilbur C. Knight, under the title of 'Some New Data for Converting Geological Time Into Years,' seem very timely. The opportunities for making such calculations of the rate of retreat of cliffs under the action of subærial decay, by employing slow-growing trees on the escarpments as a chronometer, are far wider spread than at first thought might seem likely.

In justice to the maiden work of a now eminent American geologist, it is proper to recall the fact that the first suggestion of this method and its first practical application were made by Dr. G. K. Gilbert, in 1866, when temporarily connected with the staff of the New York State Museum. After the excavation of the mastodon skeleton now standing in the State Museum, from a glacial pot hole in the valley of the Mohawk river at Cohoes, N. Y., Mr. Gilbert gave attention to an estimate of the rate of retreat of the cliffs of the river gorge, basing his observations on the degree to which the roots of the red cedars on the banks had been exposed by the falling away of the rock face. Mr. Gilbert's observations and deductions were published in the 21st annual report on the New York State Cabinet of Natural History (1871), and I quote from them the following paragraph: "Climbing from below or lowered by a rope from above, I have examined nearly all these trees and measured in each case the circumference of trunk and length of exposed root. I have also counted the rings of annual accretion of several sections to ascertain the relation of size to age. From these data an idea may be obtained of the rate of recession of the cliff. The growth is exceedingly slow. A branch of one and one-eighth inch in diameter showed 100 rings of growth, and an average of six such branches gave 72 years per inch of diameter. The figures used below were obtained from two sections of trunks. One of these measures 19½ inches in circumference and exhibits 310 rings; the other gave 11 inches and 270 rings. In these an inch of circumference represents 19.1 years, and an inch of diameter, 60 years."

He then gives a tabulation of results derived from 19 of these ancient gnarled cedars and by dividing the average measured length of exposed root by the average estimated age of the tree, arrives at the figure 15.2 inches as the rate of retreat of the rock face per century. This figure for other considerations he reduced to 12 inches per century and upon this calculation bases his final statement: "This gives as the time necessary to have removed the banks below the fall [Cohoes] from the deep channel to their present position, 35,000 years, which period I consider a minimum for the time that has elapsed since Cohoes falls were opposite the mastodon pot hole."

Twenty years ago the writer applied the same method to a calculation of the rate of retreat of the shale escarpments along Canandaigua Lake, N. Y., where these ancient cedars were at that time abundant, and had the satisfaction of arriving at a conclusion very like that obtained by Mr. Gilbert. Just where the weakness in such calculations may lie is not at once evident unless there be one in admitting the *annual* value of the growth rings in the tree. Mr. Gilbert's method, now revived by Professor Knight, merits renewed and general application. Employed with caution and care to exclude diverse agencies of retreat, it ought to afford eventually, important conclusions.

JOHN M. CLARKE.

ALBANY, N. Y.

NEWSPAPER SCIENCE.

TO THE EDITOR OF SCIENCE: So much has been published far and wide this last summer about my intention 'to scientifically demon-

strate the immortality of the soul within a year,' that it is due to the facts bearing upon the choice between materialism and spiritism to say that I have never made any such professions as have been alleged. I wish to make this statement, because I shall leave no excuse in my report of my facts for judging of them from that point of view. Whether they have any value or not I do not care to say, as I am not the person to urge that view of them. I merely wish the scientific public that still has the bad habit of reading and believing the newspapers to know that I was careful to deny that I made any such pretensions as were so generally attributed to me. More than one-half the interviews alleged to have been held with me were the fabrications of reporters who never saw me, and the other half omitted what I did say and published what I did not say. There would be no reason to make this correction at all except that the wide currency given to a pretension that I never entertained creates a standard by which I am far from estimating the facts myself, and much less can I expect others to treat it with respect. It is true that I have reversed my preferences in the choice between spiritism and materialism on account of ten years study of the Piper case, but I have done so on grounds that must force respect, even when they do not produce conviction; and the only object I had in facing public scorn was to make it as respectable to study these phenomena as it is to investigate insanity and other abnormal facts. There is a perfectly inexcusable cowardice in the attitude of scientific men toward the claims of spiritualism, and they are treated with a contempt which men would be ashamed to exhibit toward the phenomena of insanity. Hence having a body of facts for which I can safely demand consideration on some theory, I have only thrown down the gauntlet to those who have not accepted telepathy and simply ask that they turn the balance in favor of that hypothesis, instead of the spiritistic for which I have merely declared a preference, but which I should be the first to surrender, if science establishes a preference for the infinite in a woman's skull. But what I shall have to report must not be estimated as an attempt to demonstrate anything even to myself, to say nothing of those who have neither studied the subject nor taken the pains to question the authority of respectability.

James H. Hyslop.

Columbia University,
New York.

NOTES ON ORGANIC CHEMISTRY.

In the usual methods of quantitative analysis by electrolysis, the cathode is usually a platinum cone or cylinder, giving greater current on the exterior than in the interior, and an unequal deposition of the metallic deposit. In Oettel's improvement a platinum plate is used as cathode, with a fork-shaped anode, one arm on each side of the cathode. This is only partially successful in overcoming the difficulties, the deposit tending especially to scale off. In the *Berichte*, Clemens Winkler suggests the use of platinum gauze as a kathode. The metal is deposited very regularly even with strong current. It is in the form of a cylinder around each thread of gauze, is compact, firmly deposited, and shows no tendency to scale off, even at very considerable current strength. The time required is only about one-fourth as great as with the old form of electrode. Many solutions are therefore available which could not otherwise be used, as, for example, copper is readily deposited in large quantities from its sulfate solution.

In the last number of the *Bulletin* of the French Chemical Society, Weisberg gives a large series of experiments as to the power of aqueous solutions of sugar to dissolve lime. The amount which can be thus dissolved is about 27 grams of lime per 100 grams of dissolved sugar. In solution with very little sugar the relative amount of lime taken up is larger than this, but the absolute amount is of course small. Previous observations are confirmed that lime in its anhydrous form, CaO, is more soluble in sugar solutions than is its form of calcium hydroxide or milk of lime.

Some time since the use of calcium carbid as a reducing substance for high temperatures was suggested by Warren. This subject has now been worked up by Tarrugi in the *Gazetta*, and he finds most metallic salts are decomposed

with great ease with the formation of calcium alloys, and, in a few cases, of the free metal. As this is the case with chromium, it may be possible to devise a commercial method for its manufacture by the use of calcium carbid.

SOME years ago the sterilization of water by chlorid of lime (bleaching powder) was suggested by Traube, and the subject was further studied by Bassenge. In a recent number of the *Hygienische Rundschau*, A. Lode, of Innsbruck, describes further experiments along the same line. The process, as practically carried out, demands 0.15 gram of commercial, dry chlorid of lime per liter of water to be purified. This is rubbed with an equal weight of water in a porcelain dish, or on a large scale in a suitable wooden or stone vessel, to a thin paste, and added with constant agitation to the water. The corresponding amount of hydrochloric acid, for which the author gives a table, is then added. In the course of half an hour the water has cleared and 0.3 grams of sodium sulfite per liter is added. The cost of the process is found to be about 8 cents per cubic meter of water. It is claimed that by this process the water is completely sterilized, and even very bad waters rendered potable.

J. L. H.

THE NOVEMBER METEORS OF 1899.

PROFESSOR E. C. PICKERING has sent from the Harvard College Observatory the following account of the approaching meteoric shower:

The predicted time of maximum of the November meteors is November 15, 1899, at 18 h. Greenwich mean time. As a similar shower may not occur again for thirty years, no pains should be spared to secure the best possible observations. The most useful observations that can be made by amateurs are those which will serve to determine the number of meteors visible per hour throughout the entire duration of the shower. They should be made on November 15th, and also on the two preceding and following evenings. The most important time for observation is from midnight until dawn, as comparatively few meteors are expected earlier. Observations are particularly needed at hours when they cannot be made at the observatories of Europe and America. In general, the time required for ten or more meteors to appear in the region covered by the accompanying map, should be recorded. This observation should be repeated every hour or half hour. If the meteors are too numerous to count all those appearing upon the map, the observer should confine his attention exclusively to some small region, such as that included between the stars μ Ursae Majoris, 40 Lyncis, δ and a Leonis. If the meteors occur but seldom, one every five minutes, for instance, the time and class of each meteor should be recorded. Also note the time during which the sky was watched and no meteors seen, and the time during which that portion of the sky was obscured by clouds. Passing clouds or haze, during the time of observation should also be recorded. The date should be the astronomical day, beginning at noon, that is, the date of early morning observations should be that of the preceding evening. Specify what time is used, as Greenwich, standard, or local time. When a meteor bursts, make a second observation of its light and color, and when it leaves a trail, record the motion of the latter by charting the neighboring stars, and sketching its position among them at short intervals until it disappears, noting the time of each observation. If the path of a meteor is surely curved, record it carefully upon the map.

On November 14, 1898, thirty-four photographs were obtained of eleven different meteors. Their discussion has led to results of unexpected value. The greatest number of meteors photographed by one instrument was five. Only two meteors were photographed which passed outside of the region covered by the map, although the total region covered was three or four times as great. No meteors fainter than the second magnitude were photographed.

Photographs may be taken, first, by leaving the camera at rest, when the image of the stars will trail over the plate and appear as lines, or secondly, attaching the camera to an equatorial telescope moved by clockwork, when a chart of the sky will be formed, in which the stars will appear as points. A rapid rectilinear lens is to be preferred in the first case, a wide-angle lens in the second. The full aperture should be used and as large a plate as can be covered.

The most rapid plates are best for this work; they should be changed once an hour, and the exact times of starting and stopping recorded. Care should be taken to stiffen the camera by braces, so that the focus will not be changed when the instrument is pointed to different portions of the sky, especially if the lens is heavy. If the first method is employed, the position of the camera should be changed after each plate, so as to include as much as possible of the region of the map on each photograph. If pointed a little southeast of ε Leonis, the radiant will reach the center of the field about the middle of the exposure. A watch of the region should also be kept, and the exact time of appearance and path of each meteor as bright as the Pole Star should be recorded. The plates should be numbered on the film side with a pencil, and should be sent to the Harvard Observatory with accompanying notes and other observations. After measurement there, they will be returned if desired. The value of the results will be much increased if similar photographs can be obtained by a second camera from ten to forty miles distant, and preferably north or south of the other.

OBSERVATION OF THE TOTAL SOLAR ECLIPSE IN 1900.

President Harper, of the University of Chicago, at the 30th Convocation of the University on October 2d, spoke as follows of plans for observing the approaching solar eclipse:

A total eclipse of the sun is regarded as an event of great importance by astronomers, because of the opportunity it affords for studying the solar corona and other phenomena which are invisible at other times. The last total eclipse visible in the United States occurred on July 1, 1889, and a great number of astronomers from the various observatories visited California for the purpose of making observations. The next total eclipse will occur on May 28, 1900, the path of the shadow extending through the States of Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi and Louisiana. Extensive preparations for observing it are being made by many institutions. General arrangements have been entrusted to an Eclipse Committee, of which the Director of the Yerkes Observatory is Secretary, appointed last year, at the Harvard Conference of Astronomers and Astrophysicists.

(1) Photographic observations of the spectrum of the sun's edge, similar to those made at the recent eclipses in India and Nova Zembla, but with more powerful apparatus.

(2) Photographs of the corona on a large scale, for the purpose of showing the detailed structure.

(3) Measurement of the heat radiation of the corona.

This last investigation has not been carried out successfully at any previous eclipse. Special instruments have been devised for the purpose, which promise to give interesting results. Professor Nichols, of Dartmouth College, who, in the summer of 1898, succeeded for the first time in detecting heat radiation from the stars, at the Yerkes Observatory, has offered to assist in making these measurements and expects to furnish part of the apparatus.

The Yerkes Observatory did not have the means to send an expedition to the last eclipse, which occurred in India in January, 1898. As the present occasion is so favorable, and as the expense involved is comparatively small, it is hoped that the friends of the observatory will make it possible to send out a party. The expenses will include a large heliostat, with accessory apparatus for determining the radiation of the corona and for photographing the corona on a large scale; transportation expenses for four astronomers, freight and express charges, teaming, lumber, brick, cement, labor, etc. (for the construction of temporary shelters for the instruments and piers). Other apparatus, including spectroscopes, telescopes, and all mirrors for the heliostat, etc., will be supplied from the Yerkes Observatory. The heliostat and other instruments to be purchased will become an important part of the permanent equipment of the observatory, to be used in its daily work on the sun.

On account of the exceptionally favorable atmospheric conditions which prevail at Lake Geneva during the day, special attention is given at the Yerkes Observatory to the study of the sun. A number of important advances in our

knowledge of the sun have recently been made here, and when the instrumental equipment now in process of construction has been completed, this observatory will be able to undertake more solar work than any other institution. It is, therefore, of special importance that a party should be sent from here to observe the eclipse of May 28, 1900 (probably to Georgia), particularly as the next total eclipse visible in the United States will not occur until 1918. As the work which has been planned for this party will require special instruments constructed for the occasion, the expense of the expedition will amount to about $3,000. It is proposed to undertake three special lines of work.

THE IMPERIAL DEPARTMENT OF AGRICULTURE IN THE WEST INDIES.

WE have already given some account of the Imperial Department of Agriculture in the West Indies, established by the British Government, with Dr. Daniel Morris as Commissioner. The *Experiment Station Record*, quoting from the first number of the *West Indian Bulletin*, the official organ of the Department, gives an account of its work. In accordance with the recommendations of the West Indian Royal Commission, appointed in December, 1896, the British Government has appropriated £4,500 for the new department for the first year, and it is estimated that in future an annual grant of £17,500 will be required to carry out the recommendations of the Commission as adopted.

The headquarters of the department are at Barbadoes. Its duties are twofold: "(1) To endeavor to restore the sugar industry to a condition in which it can be profitably carried on, and (2) to encourage the establishment of other industries in such colonies as afford suitable conditions to supplement the staple industry."

Four 'principal' or 'central' experiment stations and eight 'local' stations for the improvement of the sugar cane will be established on the island of Barbadoes. The object of the central stations will be the growing of seedlings and improvement of varieties, and the carrying on of fertilizer experiments. The more promising varieties will be given a practical trial at the local stations to test their adaptability and value in different soils and localities, and also as a demonstration to the planters in each parish. Experiments on similar lines have been arranged for at Antigua and St. Kitts, while the work previously inaugurated at Trinidad will be largely extended and the necessary chemical assistance provided. The botanic stations placed under the control of the department are those at Tobago, Grenada, St. Vincent, Barbadoes, St. Lucia, Dominica, Montserrat, Antigua, and St. Kitts-Nevis. The object of these stations is to test and distribute promising economic plants for the region, introduce new or little-known plants for experimental cultivation, and conduct experiments on the improvements of sugar cane. In addition they distribute information, and send out lecturers for institute work.

It is also proposed to establish central sugar factories equipped with the best machinery, and it is the expectation of the department to establish one or two experimental factories at an early date. The plan of the Royal Commission to establish agricultural schools in connection with the botanic stations has been carried out by opening a school at Dominica, and others will be started at St. Vincent, St. Lucia and St. Kitts-Nevis as soon as the necessary land is obtained. Furthermore, the department is prepared to offer grants to enable certain institutions to employ teachers in agricultural science, and possibly to provide a number of scholarships and in coöperation with the central educational authorities in each colony, the teachers in the elementary schools will be given a course of instruction in the principles of agriculture, to enable them to give simple instruction and conduct school gardens. It is proposed to attach an agricultural instructor to each of the botanic stations, who will travel about holding meetings and demonstrations, and imparting information on improved methods directly to the planters; and in addition instructors or experts in special lines, will be employed to spend a month or two on each island. The publications of the department will include handbooks on the cultivation of special crops, bulletins and leaflets—the latter especially being in very simple clear language. The *West Indian Bulletin*, mentioned above, will be issued by the department periodically.

THE PROPOSED NATIONAL UNIVERSITY.

THE committee appointed by the National Educational Association to consider the advisability of establishing a national university met in Washington on November 3d, and unanimously agreed upon a preliminary report recommending that no new university be established, but indicating the advisability of using the collections and resources of the government for advanced work and the establishment by the government of a school for consuls. The report of the committee is as follows:

(1) It has been, and is, one of the recognized functions of the federal government to encourage and aid, but not to control, the educational instrumentalities of the country.

(2) No one of the bills heretofore brought before Congress to provide for the incorporation of a national university in Washington commends itself to this committee as a practical measure.

(3) The government is not called upon to maintain at the capital a university in the ordinary sense of that term.

(4) That a sub-committee be requested to prepare for consideration by the full committee a detailed plan by which students, who have taken a baccalaureate degree, or who have had an equivalent training, may take full and systematic advantage of the opportunities for advanced instruction and research which are now, or may hereafter be, afforded by the government; such a plan to include the coöperation with the Smithsonian Institution of the universities willing to accept a share of the responsibility incident thereto. It is understood that the financial administration of this plan should be such that whether or not government aid be given, there shall be no discouragement of private gifts or bequests. It is understood that the scope of this plan should be indicated by the governmental collections and establishments which are now available, or as they may hereafter be increased or developed by the government for its own purposes.

(5) The government, through the State Department, might wisely maintain in Washington a school for consuls, analogous to West Point and Annapolis, and make these schools lead to a life career in the government service.

RESOLUTIONS OF THE SEVENTH INTERNATIONAL GEOGRAPHICAL CONGRESS.*

(1) THE Congress appoints a Committee of Bio-geographers resident in or near Berlin to draw up a uniform scheme of nomenclature for plant formations, and after consultation with non-resident specialists, to revise the same and present it to the Eighth Congress.

(2) The Congress believes that the plans for international coöperation in Antarctic exploration form an excellent basis for joint research in physical geography, geology, geodesy and biology. With regard to meteorological and magnetic work, however, they appoint an international committee to determine the general scheme and methods to be employed on the expeditions, and to endeavor to organize a system of simultaneous observations in the regions surrounding, but exterior to, the Antarctic.

(3) The Congress expresses the earnest desire that all maps, including those published in countries using English and Russian measures, should, in addition to the graphic scale, bear the proportion of lengths on the map to those in nature in the usual form $1 : x$.

(4) The Congress views it as desirable that the publication of all new geographical material accompanying accounts of travel, should be supported by details regarding the methods of surveying, the instruments employed, and their verification, the calculation of astronomical positions with their probable error, and the method of utilizing these data in preparing the map. Also that all maps published by scientific men, institutions or governments should be accompanied by notes of the principal fixed points.

(5) The Congress expresses the hope that a uniform system of measures will be used in all geographical researches and discussions, and recommends that the metric system of weights and measures be so employed.

(6) The Congress expresses the hope that in scientific publications the centigrade thermometer scale should, as far as possible, be employed; or, at least, the values in centigrade degrees added to those expressed on the scales of Fahrenheit or Réaumur.

(7) With regard to the proposal to introduce

* From *Nature*.

a decimal division of time and angles, the Congress desires to preserve the present division of time and of the circumference into 360°, but allows that the adoption of a different subdivision of the angle might be studied, and considers that in certain cases the decimal subdivision of the degree of arc presents no objection.

(8) The Congress is of opinion that the *Bibliotheca Geographica*, published by the Berlin Geographical Society, may be accepted as an efficient international bibliography of geography.

(9) The Congress considers the construction of statistical population maps to be very desirable, and appoints an international committee to draw up a scheme, at the same time expressing the hope that national committees will be formed in various countries to promote the preparation of such maps.

(10) The Congress considers the collection of data as to the distribution of floating ice to be very important, and appeals to the hydrographic and meteorological institutes of the countries whose ships frequent high latitudes to induce the masters of vessels to keep a regular record of the occurrence of drifting ice. The Congress believes that the Danish Meteorological Institute in Copenhagen is the best adapted as an international centre for collecting the records.

(11) The Congress nominates an international committee to consider the nomenclature of the floor of the ocean, and to produce and publish at latest in time for the next Congress a chart of the ocean with revised nomenclature.

(12) The Congress hopes that the names of oceanic islands, especially in the Pacific, will be revised with a view to ascertaining and preserving the native names. Where no native names exist or can be ascertained, the names given by the discoverers should [be used. The arbitrary changing of established names ought to be opposed by every means.

(13) The Congress recognizes the desirability of obtaining data for a more exact estimate than now exists of countries in which there is no means of taking a census, and desires to bring the matter to the notice of such Governments as have foreign possessions.

(14) The Congress expresses sympathy with the proposal to equip an expedition in New South Wales, with the sole object of endeavoring to discover remains or traces of the route of the Leichhardt expedition, which perished in the interior of Australia fifty-two years ago.

(15) The Congress is favorable to the foundation of an international seismological society, and appoints an international committee for the study of earthquakes.

(16) The Congress believes the production of a map of the world on the scale of 1: 1,000,000, the sheets bounded by meridians and parallels, to be both useful and desirable. The Permanent Bureau of the Congress is instructed to deal with the question, and in the first instance to secure the preparation of a projection for the map with degree lines on the determined scale.

(17) The Congress considers the establishment of an International Cartographical Association of service, and appoints a committee to take preliminary steps.

SCIENTIFIC NOTES AND NEWS.

THE family of the late Dr. Daniel Garrison Brinton have requested Mr. Stewart Culin, of the University of Pennsylvania, to prepare a memoir of the distinguished Americanist. Mr. Culin is desirous of obtaining copies of Dr. Brinton's letters and other literary materials, which may be sent him at the University of Pennsylvania.

PROFESSOR SIMON NEWCOMB has returned to Washington from Europe. His last official services while abroad were to represent, together with Professors Remsen and Bowditch, the National Academy of Sciences at a conference held at Wiesbaden, on October 10th and 11th, to form an International Association of Academies.

SIR WILLIAM MACCORMAC, president of the Royal College of Surgeons, and one of the greatest authorities on gunshot wounds, has volunteered his services in South Africa, and the British War Office has accepted his offer.

MR. ALEX EVERETT FRYE, the geographer, has been appointed superintendent of schools for Cuba.

THE daily newspapers report that Professors Lengfeld and Smith and four students have

been injured by the explosion of chemicals in the Kent Laboratory of the University of Chicago.

Dr. Marcus Baker, who was one of the experts assisting the United States members of the Venezuela arbitration commission at Paris, has returned to Washington.

Dr. Luther Dana Woodbridge, since 1884 professor of anatomy and physiology in Williams College, died suddenly of heart disease at his home in Williamstown on November 3d. He was born in 1850 and was a graduate of Williams College and of the College of Physicians and Surgeons, Columbia University.

The death is announced of the African explorer, Dr. Oscar Baumann, born in Vienna in 1864. In 1885 he acted as geographer to the Austrian Congo Expedition, subsequently visiting the island of Fernando Po, the Cameroons and part of East Africa. He made several further trips to Africa on one of which he explored Usambara and made studies for the projected railway from Tanga to Karog.

Dr. J. W. Hicks, fellow of Sidney-Sussex College, Cambridge, and Bishop of Bloemfontein, Orange Free State, has died at the age of fifty-nine. He was at one time demonstrator in chemistry in the University, and was the author of a text-book of inorganic chemistry; he was also doctor of medicine.

We also regret to record the deaths of Dr. F. Kuhla in Manaos, Brazil, where he was engaged in botanical explorations; of Percy S. Pilcher on October 2d, as the result of an accident while experimenting with flying machines on September 30th, and of Professor Hayduck, privat docent for chemistry at Berlin.

The National Museum has recently come into possession of a large portion of a stony meteorite which fell at Allegan, Michigan, on July 12th last. A preliminary examination shows the stone to be of the chondritic type, composed essentially of olivine and enstatite with the usual sprinkling of particles of metallic iron and undetermined sulphides. The stone will be known as the Allegan meteorite, and as soon as described will be in part broken up and made available for exchanges with other institutions. The Museum has also received, through Mr. O. C. Charlton, of Waco, Texas, permission to study and describe an iron meteorite found near Mart, McLennan County, in the same state. This mass weighed, entire, 19¼ pounds and will be known as the Mart iron.

The report of the Australian Museum for 1898 again notes that the appropriation for its maintenance is entirely inadequate and that the Museum is forced to depend entirely on its friends for any increase of the collections. Fortunately the friends are numerous as is shown by the many accessions. There is, however, a special appropriation for the construction of the superstructure of the new wing, the basement, which is devoted to workrooms, having already been built. It is noted that a new and satisfactory crematory has been erected so that as regards facilities for the work of preparation, the Australian Museum is probably far in advance of any institution in the United States, save possibly the Wistar Institute. Part 6 of the Memoir on Funafuti has been published, and two parts of a revised catalogue of Australian birds, and it is announced that the report on Funafuti will be finished this year and that on the Thetis trawling expedition commenced. The Australian Museum is to be congratulated on the amount of work it is able to do with its small appropriation.

Nature reports that at a meeting of the Council of the London Mathematical Society, it was resolved that the president (Lord Kelvin,) the three vice-presidents, the treasurer, and the two secretaries should be nominated for the same offices at the annual meeting on November 9th next. Of the other members, Messrs. W. H. H. Hudson, D. B. Mair and W. D. Niven, C.B., retire from office, and Messrs. W. Burnside, H. M. Macdonald and E. T. Whittaker were nominated to fill the vacancies. The Council also empowered the secretaries to publish an 'Index' to the first thirty volumes of the *Proceedings*, on the lines of the similar index to the first fifty volumes of the *Mathematische Annalen*. Mr. Tucker was further authorized to draw up a complete list of members from the foundation of the society in 1865.

At the first general meeting this season of

the members of the Boston Society of Natural History, held on November 1st, a paper was read by Professor W. M. Davis on 'Geographical Notes of a Year in Europe.'

PROFESSOR LEITH, on taking the new chair of pathology and bacteriology at Mason University College, Birmingham, on October 9th, delivered an address on the advance of bacteriological science in the diagnosis and prevention of disease.

THE library of Harvard University has sent out circulars to various cattle-breeders' associations throughout the country, requesting them to contribute complete files of their published pedigrees of cattle, horses, sheep and swine. The collection is to aid students in research into the heredity of domesticated animals, and will be placed in the Museum of Comparative Zoology.

A SOMEWHAT acrimonious attack has been made by 'a correspondent' in the Aberdeen *Free Press* upon the trawling work of the Scottish Fisheries Commission. The article has been reprinted and is said to have been widely distributed. The author concludes "that their so-called scientific experiments on trawling have been carried on with no regard whatever to uniformity and in such a slip-shod manner that the public money might, considering the results accruing, have been more profitably thrown into the sea." The author does not explain how the greater profit from the sea is to be secured. He demands an investigation of the work.

ACCORDING to *Nature*, a scientific and commercial mission, under the directon of M. Ernest Milliau, Director of the Laboratory of Technical Experiments in connection with the Ministry of Agriculture, Paris, has been sent to Russia and Roumania with the object of taking measures for facilitating and extending business relations with those countries, especially with regard to the exportation of olive oils.

THE New York *Evening Post* states that Dr. Robert T. Hill of the United States Geological Survey and four companions have arrived at Langtry, Texas, from a voyage through the cañons of the Rio Grande, their trip being the second successful one down that river ever attempted. The party left Presidio, Texas, and completed the five hundred miles of the tortuous course of the river without seeing a human habitation. Veins of gold and silver-bearing rock were seen at several points, and there were indications in the almost inaccessible cañons that they had at one time been occupied by cliff dwellers, but it was found impossible to explore the ruins from below.

MR. JOSEPH B. BANCROFT, of Hopedale, Mass., has built a public library building for that town, at a cost of $50,000, which will be dedicated during the present month.

THE School Board of the City of Chicago has decided to appoint fifty medical inspectors with special reference to preventing the spread of contagious diseases among children. The inspectors will examine pupils who have been absent from school four days or more and all those who show symptoms of fever or sore throat. The plan, which is modeled on that already adopted in New York and Boston, will be tried for two months as an experiment.

THE Committee of the British Association Table at the Naples Zoological Station announces, says *Nature*, that the Table is fully occupied until the middle of April next, but that applications for its occupancy from then until the end of August, 1900, should be sent at once to the Hon. Secretary of the Committee, Professor Howes, F.R.S., at the Royal College of Science, South Kensington. Mr. Kyle will occupy the table from now until Christmas, when he will be succeeded by Mr. M. D. Hill, who will continue investigations on the reproduction processes of Crustacea, and in March Professor Herdman will go out and devote a month to the study of the Tunicata of the Bay.

UNIVERSITY AND EDUCATIONAL NEWS.

MAJOR HENRY LEE HIGGINSON, of Boston, has given $150,000 to Harvard University for the establishment of a university club, and the corporation offers as a site the property at the corner of Harvard and Quincy streets.

IN the Supreme Court of the United States, on October 30th, the petition for a writ of *cer-*

tiorari in the Fayerweather will case was denied. It is reported, however, that the contest involving, it will be remembered, some four million dollars for American colleges is not yet settled.

Liverpool University College has received for its physical laboratories two checks of $5,000 each from Mrs. George Holt and her daughter, Miss Emma Holt.

Arrangements are being made under the direction of Mr. H. J. Rogers, of Albany, for the United States educational exhibit at the Paris Exposition of 1900. It is planned to represent the university system of the United States by letting the different universities each represent some special departments, so that the collective exhibit may not be of separate universities, but of higher education as a whole. In scientific work Johns Hopkins University will exhibit its departments of physics, geology, and the medical sciences, the University of Pennsylvania its archæological collections, Columbia University its library and its work in education and psychology, and Harvard University its astronomical observatory.

The Technical Institute at West Ham, London, was destroyed by fire on December 23, 1898. The fire originated in the chemical laboratory. The loss is estimated at over £80,000 and is only partially covered by insurance. The adjacent Natural History Museum, the gift of Mr. Passmore Edwards, which is now approaching completion, was fortunately saved as were also the books from the free library.

The number of new matriculations at Cambridge University was this year 893 as compared with 902 in 1898 and 884 in 1897.

Dr. Alonzo E. Taylor, Assistant Director of the Pepper Laboratory of the University of Pennsylvania, has been appointed professor of pathology in the Medical College of the University of California.

Dr. Alex. Hill, Master of Downing College, in his speech to Congregation on resigning the office of Vice-Chancellor of the University of Cambridge, stated, says the British *Medical Journal*, that the amount already received towards the Benefaction Fund instituted at the meeting over which the Duke of Devonshire presided at Devonshire House, amounted at the end of the financial year, to £50,000. It had thus been made possible to consider the erection of new buildings for law, medicine, botany and archæology. The response, however, had not been sufficient to warrant any of the new developments of University work which many friends of the University desired. In the interests of national progress, Dr. Hill said, it was greatly to be desired that laboratories of applied science should not be isolated but should be established in connection with schools which were already strong in pure science. Technical training in any limited sense of the expression was impossible. In every subject of practical application—whether it were to a learned profession or an industrial art—success depended upon breadth of knowledge of the sciences upon which the profession or art was based. Advances in technology were almost invariably due to the application by practical men of principles discovered by those who carried out investigations in pure science. Conversely, the strength and vitality of a school of pure science was largely increased when opportunities were afforded to students of passing on to its applications. The remarkable progress of natural science in Cambridge was closely associated with the growth of the medical school. During the past twelve years a larger number of students had entered for the Natural Science Tripos than for any other examination for honors, notwithstanding the fact that but few students were in a position to allow their prospects in life to depend upon the discovery in themselves of a special aptitude for pure science. Almost all those who had since distinguished themselves in various branches of science had commenced their career by preparing to qualify for a profession. The majority of the graduates, for example, who were at present prosecuting researches in the physical, chemical, botanical, zoological, physiological, anatomical and pathological laboratories, making, to the great credit of the University, additions to knowledge which were not exceeded, if they are equalled in amount, by any other university in the world, entered as medical students.

JOHN WELLS FOSTER.